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WORLD POWER CONFERENCE NUMBER

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ELECTRICAL WORLD

JUNE 28, 1930
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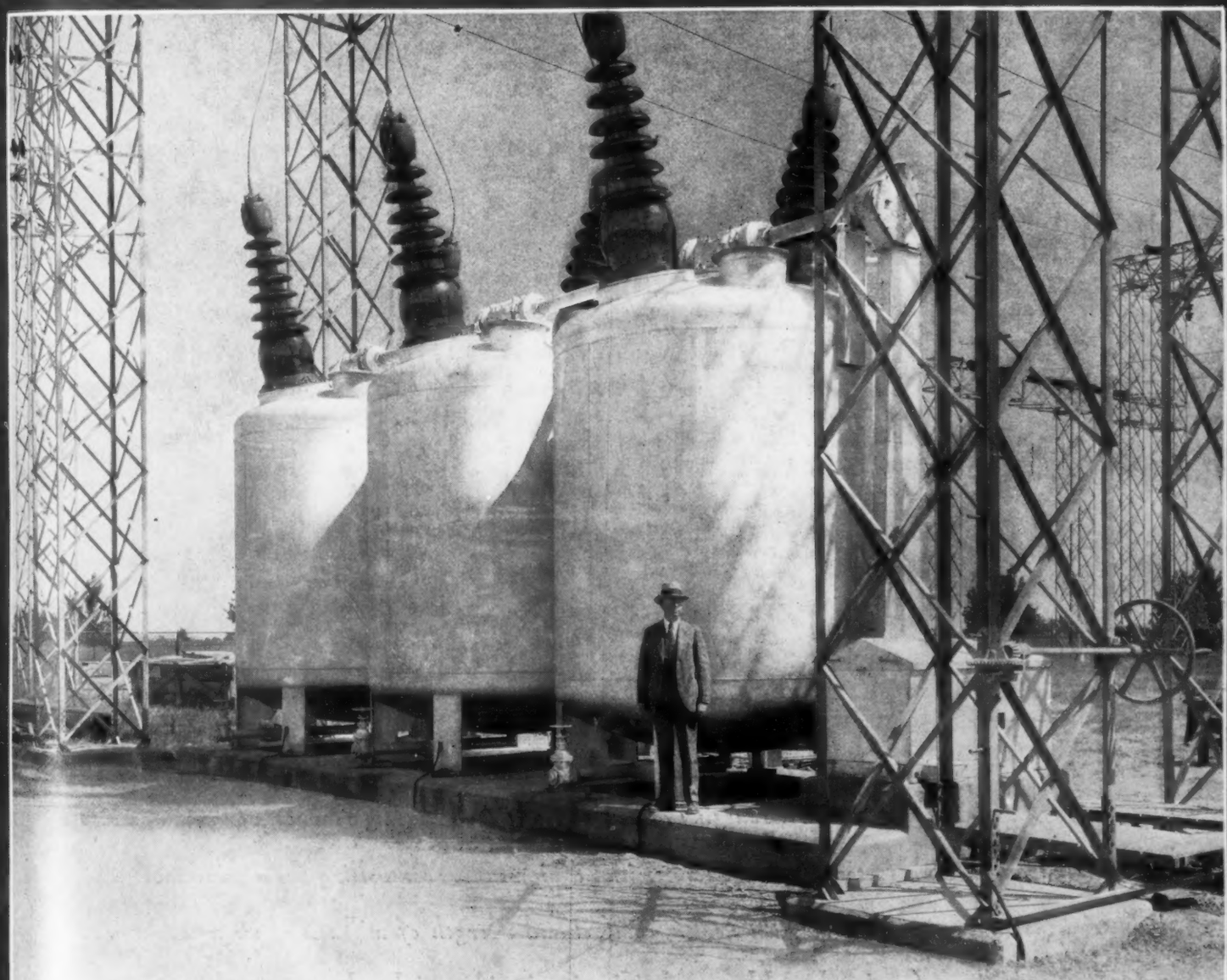

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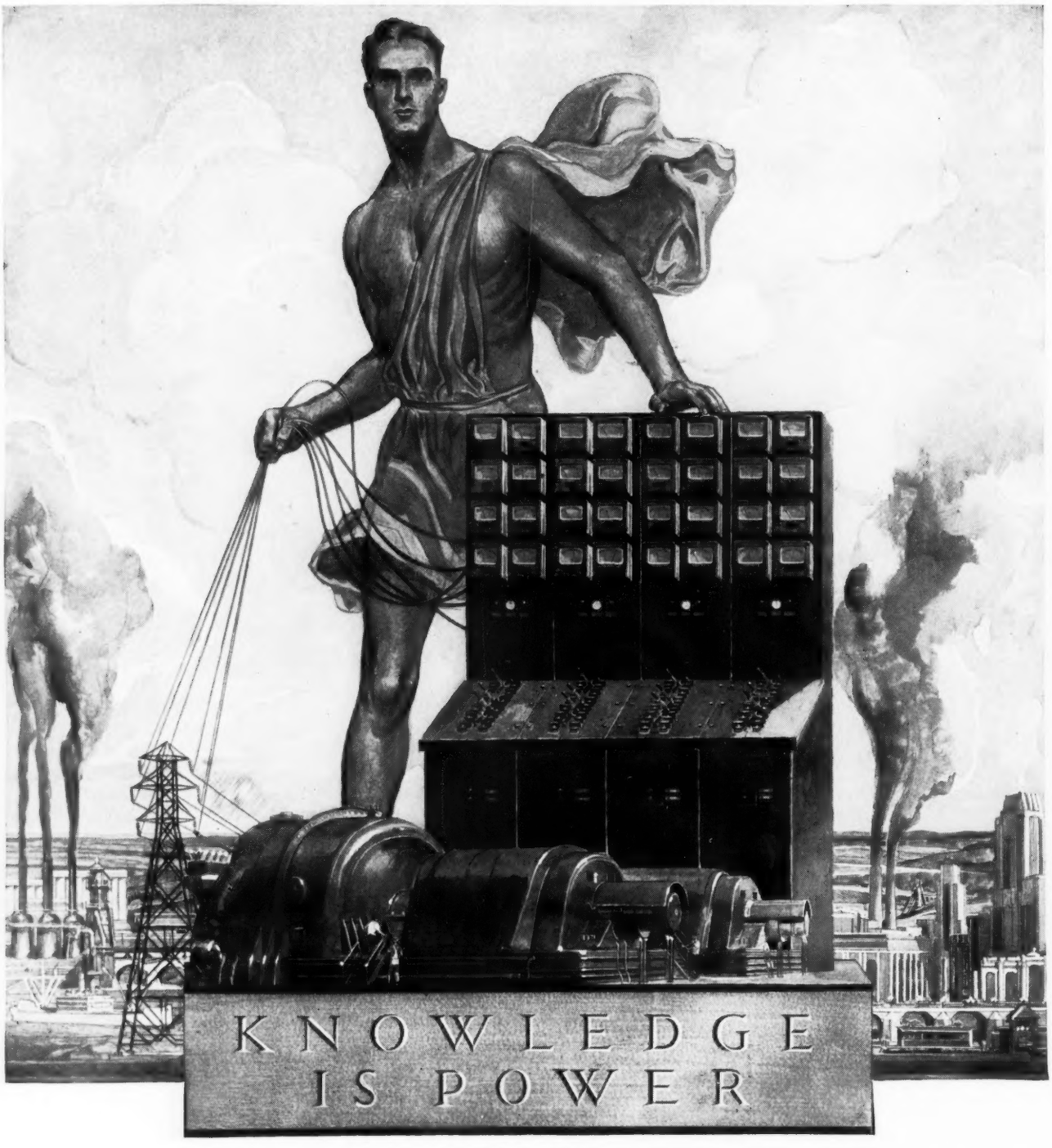

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JUNE 28, 1930

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VOLUME 95 . . . NUMBER 26

JAMES H. RUDD
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World Power Conference in Berlin

Berlin Conference Stimulating 1322
By Special Cable to ELECTRICAL WORLD

Steam Turbines for Power 1327
BY A. G. CHRISTIE

Water Power in Canada 1330
BY J. C. SMITH AND C. V. CHRISTIE

One Price for Power 1332
BY L. W. W. MORROW

Electric Rate Analyses 1336
BY L. R. NASH

Better Load Factor 1338
BY GEORGE H. JONES

More Lines, Fewer Stations 1341
BY C. L. FORTESCUE

Hydro-Steam Combinations 1343
BY N. E. FUNK

Utility and Industrial Interconnections 1345
BY GEORGE E. WHITWELL

Economics of Railway Electrification 1347
BY GEORGE GIBBS

A New Epoch Through Research 1348
BY C. F. HIRSHFELD

News of the Industry 1313

Editorials 1319

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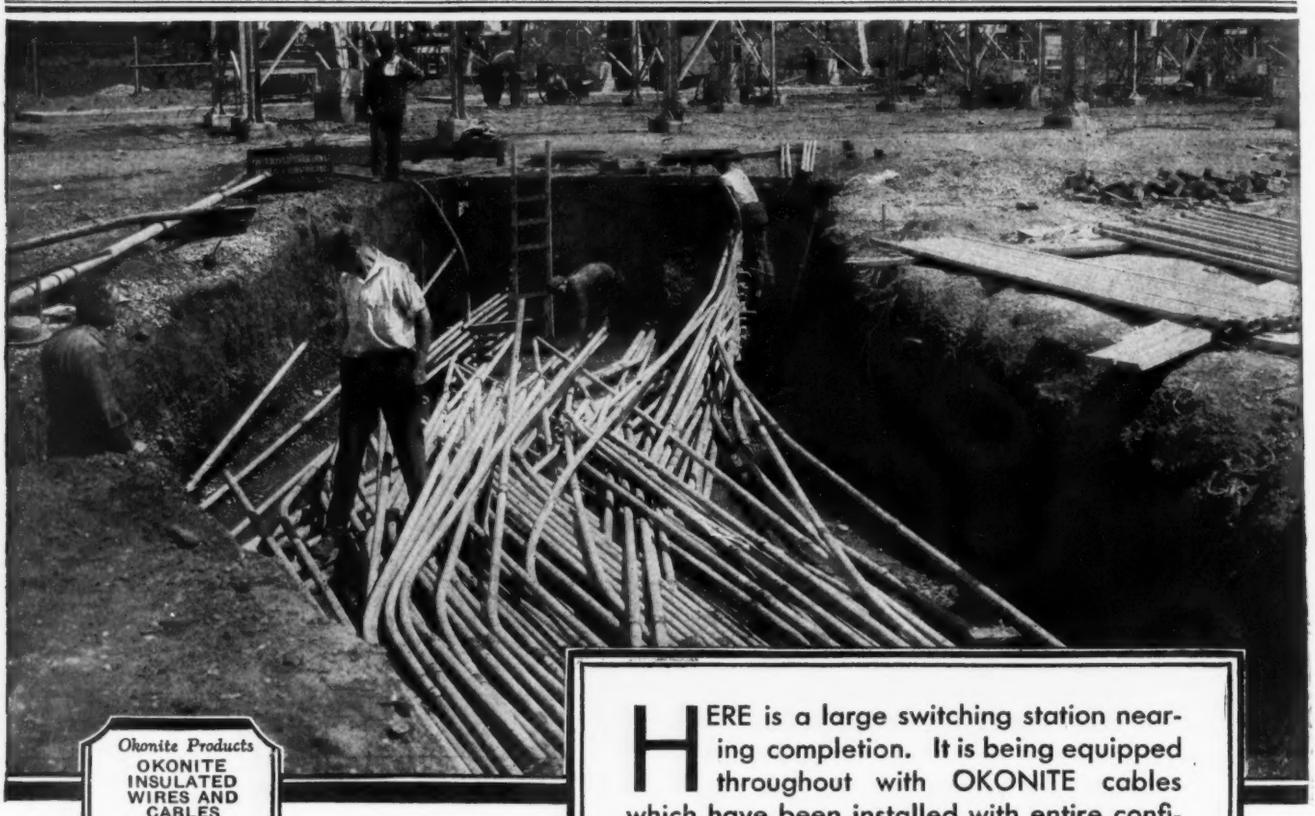

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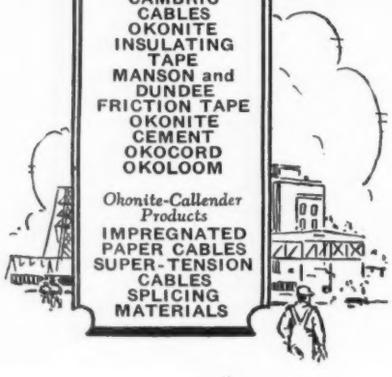

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ELECTRICAL WORLD

for the Week Ending

June 28, 1930

World Power Conference concluded

National Power & Light has hearing

Kansas City, Kan., rejects bid for plant

Power Commission bill becomes a law

—HOOVER signs the Couzens bill to reform the Federal Power Commission. Next, five commissioners must be appointed by him, and, what may be more difficult, Senate approval secured for them.

—WORLD Power Conference came to a conclusion on Wednesday. Major significance lies in better international understanding and appreciation of world-wide interest of engineering profession. Many outstanding papers were presented. The United States' invitation to hold the third plenary conference here in 1936 was accepted.

—ELECTRIC operation of railways along the seaboard from Boston to Washington predicted by Vauclain of Baldwin Locomotive Works.

—SUBATOMIC energy in a drop of water is sufficient to furnish 200 hp. for a year, Professor Eddington tells World Power group. How to release it is a matter of less certainty, however. "Tantalizing," he concedes.

—NATIONAL Power & Light Company, third Bond & Share property to cross Trade Commission stage, receives familiar emphasis. Once again are differences between utilities and investigators proved to be largely a matter of viewpoint as to business ethics.

—KANSAS CITY (Kan.) Commissioners and Mayor unanimous in rejection of $7,000,000 offer for present municipal power system. Utility promoter appears to yield the issue.

—DISASTER met the daring plan of Georges Claude of France to generate 12,000 kw. at Matanzas, Cuba, by using sea water at two temperatures in low-pressure turbines, his giant power tube being lost as the cables connecting it to shore broke.

—MINERAL exhaustion need not be feared, Dr. Bain assures Berlin conference. "If the world wants minerals badly enough to pay for them they will be forthcoming." Deeper strata seen as remedy.

NEWS OF THE WEEK

Power Questions Settled and Unsettled Figure in Washington News

PRESIDENT HOOVER on June 24 signed the bill providing for the reorganization of the Federal Power Commission. Nominations of the five commissioners had not been forwarded to the Senate at this writing, but the President has indicated that he will make the appointments at an early date.

Despite opposition from Arizona, the section of the second deficiency bill appropriating $10,660,000 for commencement of work on the Boulder Dam project was left in the measure as it went to the Senate. Senator Hayden of Arizona endeavored to have the appropriation stricken from the bill in the Senate appropriations committee. The committee decided, however, to report the measure to the Senate with the Boulder Dam section intact. A final vote was set for 4 o'clock on Thursday afternoon by consent of the Arizona Senators, who at first evinced a disposition to filibuster in their desire to defeat the bill.

Court action to block the Boulder Dam project was taken, however, on June 24, when an injunction suit was filed in the Supreme Court of the District of Columbia by Fred T. Colter as trustee of the Arizona Highline Reclamation Association. Mr. Colter is said to be a candidate for Governor of the state. A court order is requested for the purpose of restraining the Secretary of the Interior from taking any action under the contracts with the city of Los Angeles and the Metropolitan Water District of Southern California.

The petition claims that exploitation of water resources of the Colorado by the government constitutes a confiscation of Arizona's property without due process of law, which is a violation of the Constitution. It is stated that Arizona has made plans for the development of the power resources of the Colorado on its own behalf and that the Federal Power Commission has approved these plans. The Southern California Edison Company is not mentioned in the suit. While formal request has not been made for a temporary restraining order, it is expected that this will be done. Meanwhile, members of the Arizona delegation in Congress profess surprise over the filing of the suit. They say that Mr. Colter must be acting in his own behalf since none of the state organizations with which they are in touch have apprised them of the suit, which has been instituted by mail.

Senator Black of Alabama has introduced a resolution directing the Secretary of War to sell power generated at Wilson Dam to municipalities upon as liberal terms as power is now sold to private companies. This order would stand until final disposition is

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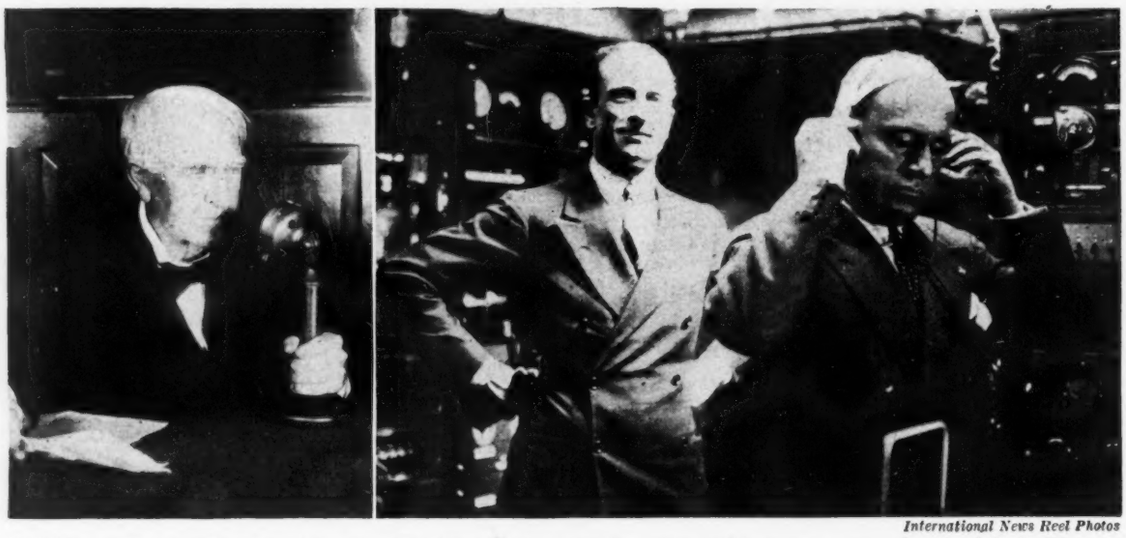
HERE ARE SOME FAMOUS LONG-DISTANCE TALKERS



International News Reel Photos

Talking across continents and oceans is becoming a routine event with many men. On the left is Thomas A. Edison sending greetings from his New Jersey home to the World Power Conference in Berlin. On the right Marconi is initiating Mussolini, who talked from the inventor's yacht in Italian waters to the latter's London office.

made of the Muscle Shoals project. Attempt to get immediate consideration of the resolution was blocked by Senator Gillette of Massachusetts.

Although the House inserted an amendment in the second deficiency bill appropriating $1,000,000 for starting work under the terms of the Cramton bill, which calls for the development of a park in the gorge of the Potomac, this amendment was stricken from the bill by the Senate appropriations committee. The Cramton bill would set aside strips of land along both banks of the Potomac between Washington and Great Falls for park purposes and would make development of the water power of the falls by private interests impossible.

With the adoption of a compromise amendment adjusting the differences between the group of senators from the Lake States and those supporting the Illinois Waterway project over the diversion of water at Chicago, passage of the rivers and harbors bill was secured in the Senate on June 20. The compromise postpones final limitation of the diversion until the waterway shall have been completed.

The petition of Walter H. Wheeler of Minneapolis for a rehearing of the Flathead (Mont.) power project proposals was denied last week by the Federal Power Commission. Secretary Wilbur, acting chairman, said the question could not be reopened legally. Reservation Indians are said to be still agitated over the situation.

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National Power & Light Has Its Turn in Inquiry

RUNNING rapidly through the structure of the National Power & Light Company, the Federal Trade Commission completed for the present its hearings on the Electric Bond & Share group during the first three days of this week. Adjournment will be taken till early in September, when the commission will resume its long-time investigation of the power industry, probably with the North American group. Though all branches of the Bond & Share interests have been through the commission mill, there is more sifting to be done after the courts have decided whether the company ledgers are subject to subpœna. The case still is pending the appointment of a special master by the United States District Court in New York, with no imminent plans as yet announced.

This week's hearings show the National Power & Light Company as organized in 1922 and operating in Alabama, Tennessee, Arkansas, Texas, New Jersey, Pennsylvania and the Carolinas. Total output in 1928 was 2,069,000,000 kw.-hr., of which 6.8 per cent was interstate. Capitalization at the end of 1928 was $124,115,000 in stock plus $9,500,000 in 6 per cent debenture bonds. The subsidiaries were supervised by contract direct with Bond & Share. Supervision fees totaled $1,692,750 during 1927.

The total ascertainable amount of write-up in fixed capital of operating utilities brought about through reorganizations effected by the National company was approximately $35,000,000. This does not include some transactions in which details as to the predecessor companies involved in the reorganization were refused to the commission examiners, nor does it include any subsidiaries of the Lehigh Power Securities Corporation. In a merger and consolidation of the Carolina Power & Light Company, the book value of $60,918,545 was $22,048,400 in excess of plant and property values on the books of predecessor companies. The Birmingham Electric Company similarly was written up $10,383,500 to a value of $37,977,800.

When the National sold the Arkansas Central Power Company to the Electric Power & Light Corporation in 1925 a profit of about $1,000,000 was realized, but no profit was recorded by the National. Proceeds from the sale were credited to investment account.

It was shown that a sum of $3,750 was paid in 1925 to the Tennessee River Improvement Association, then headed by Claudius H. Huston, for the purpose of securing a Muscle Shoals disposition. This was charged to the subsidiary East Tennessee Development Company. Payments to M. O. Leighton, Washington representative, also were shown in the testimony.

The relation of the Electric Bond & Share Securities Corporation to Bond & Share was discussed in Wednesday's session. Holding control of Bond & Share, the Securities Corporation originally was entirely owned by General Electric stockholders, some of whom subsequently sold out. Actual control rests with the directors, to whom are given blanket powers to issue additional voting stock and who, it was asserted, could thus maintain their direction. Four out of seven of them, the record showed, were connected with Morgan banks.

COMPTON SUCCEEDS STRATTON

Dr. Karl Taylor Compton (left), noted scientist, educator and contributor to pure and applied physics, was inaugurated president of the Massachusetts Institute of Technology on June 7 in succession to Dr. Samuel W. Stratton, president for the past seven years, who retires to become chairman of the corporation.

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Summer Meeting of A.I.E.E. Held in Toronto

MONDAY of this week saw the opening of the summer convention of the American Institute of Electrical Engineers at Toronto, the sessions terminating on Friday. Forty-five papers made two parallel sessions necessary on Tuesday and Friday, and three were simultaneously in progress on Wednesday morning. The afternoons were given over to entertainment and inspection trips, and the entire day on Thursday was set aside for an outing across Lake Ontario to the new Welland Canal.

Technical subjects were presented in two symposia. One, sponsored by the transmission and machinery committees, dealt with the co-ordination of insulation for the entire transmission system. The other analyzed the status of protective measures, relays and arresters and pointed the way to needed improvements. Transportation, substations and communication were also represented by four or more related papers, and the remainder of the total 45 were on a variety of subjects and interspersed throughout the program. The technical committee reports were not read, but time was set aside for their discussion and much favorable comment upon them was made.

The prize for the best 1929 paper in the field of theory and research went to K. K. Palueff for his paper on "Effect of Transient Voltages on Power Transformer Design." In the field of engineering practice the prize for the best paper was awarded jointly to R. C. Dickinson and B. P. Baker for a treatise

WORLD POWER EXECUTIVE COUNCIL MEETS AT BERLIN

As reported in "News of the Industry" last week, the International Executive Council of the World Power Conference met on June 12 and 13 to make final arrangements for the great convention which came to an end this week. Twenty-one nations were represented in this group, over which Dr. Edward Tissot of Switzerland presided.

on "Structural Development of the Deion Circuit Breaker." The presentation was followed by the address of President Harold B. Smith, in which he advocated the adoption by industry of a minimum scale of salary increments for those taking post-graduate courses so that they will be encouraged to undertake the financing of their extended education.

The feature of the convention banquet on Wednesday evening was the presentation of the Lamme medal to R. E. Hellmund, chief electrical engineer Westinghouse Electric & Manufacturing Company, for his "contribution to the design and development of electrical machinery."

Prof. C. A. Scott of Yale and A. M. Dudley of the Westinghouse company made presentation speeches, and there was also an address by Charles A. Magrath, chairman Hydro-Electric Power Commission of Ontario and also chairman of the Canadian Section of the International Joint Commission. Mr. Magrath cited the amicable negotiations of the International Joint Commission, with its unanimous findings, as pointing an index path to international peace. They are significant, he said, because they were accomplished without a neutral chairman holding the balance of power and without a permanent staff or bureau.

The new president, taking office August 1, is W. S. Lee, vice-president and chief engineer Duke Power Company, Charlotte, N. C. The new vice-presidents are: I. E. Moultrop, Boston; H. P. Charlesworth, New York; T. N. Lacy, Detroit; Prof. G. C. Shaad, Lawrence, Kan., and Prof. H. V. Carpenter, Pullman, Wash. New directors: A. B. Cooper, Toronto; A. E. Knowlton, Short Beach, Conn., and R. H. Tapscott, New York.

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Iron and Steel Engineers Take Stock of Development

APPLICATION of electric drive in steel mills continues to increase, while improvements in motors and auxiliary equipment go steadily on. Illumination levels are higher and the economic value of better lighting is more and more gaining recognition from executives. Arc welding is finding ever-expanding applications. These were among the conspicuous developments to receive attention at the convention of the Association of Iron and Steel Electrical Engineers in Buffalo, June 16-20.

The use of main-roll drives has increased until in 1929 a total of 361,300 hp. was installed, the aggregate at the close of the year exceeding 2,250,000 hp., according to the report of the electrical development committee presented by Chairman W. H. Burr. The application of large direct-current reversing-mill drives continues, one recent installation consisting of twin motors, each of 5,000 hp., driving the upper and lower rolls individually. Direct-current adjustable-speed motors are being extensively used in continuous mills.

Lighting intensities have been increased to an extent that would have been considered fantastic a few years ago. Intensities as high as 22 foot-candles are not unusual for inspection and chipping. R. F. Sanner presented the paper on steel-mill lighting problems.

The use of arc welding was brought out both in a paper by J. B. Austin and in other discussions. In motor construction the use of welded steel frames has made possible appreciable reduction in the diameter of the machine and has brought greater uniformity in the magnetic circuits. By applying the principles of steel-mill practice to arc welding great gains have been made in the strength of the joints. Impact tests show that rail joints can be made so durable that the seam outlasts the plate.

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Claude Power Tube Is Lost in Cuban Waters

DISASTER has encountered the plan of Georges Claude, French scientist and inventor, to generate power at Matanzas, Cuba, from the Gulf Stream, to the extent in the first instance of 12,000 kw., by converting the difference in temperature between the upper and lower waters into electrical energy. A tube 5,900 ft. long had been built to extend down into the ocean, and through it cold water was to be pumped to condense the vapors of warm water taken from the surface and superheated by vacuum.

The tube was lowered on Wednesday of this week, but the two cables fastening it to the shore and built with a tensile strength of 150,000 lb. per square inch parted and the tube sank in water about 2,300 ft. deep. It was valued at more than $1,000,000 and had taken 100 men three months to build.

Electric Power and Its Regulation Figure in State Politics

AGITATION over electric power and utility regulation is again making itself felt in political circles, conventions and primaries in a good many of the states. Following are some of the results so far in various regions:

INDIANA.—The Public Service Commission of Indiana and the regulation of municipally owned utilities came in for considerable discussion by the platform makers at the Democratic state convention held in Indianapolis, but the plank adopted was of a platitudinous character. The Republican state convention did not deal with the question.

LOUISIANA.—A bill to levy an occupational license tax on the sale of electric power has been introduced in the Louisiana Legislature. The act would levy a tax of one-half cent per kilowatt-hour on all power sold in the state. This is about two and one-half times the selling price of electrical energy fixed in some of the largest contracts existing in the state. Proceeds from the tax would go into the current school fund.

MASSACHUSETTS.—The Massachusetts House of Representatives passed the bill referred to on May 24 (page 1013) under which municipalities may purchase gas and electric plants from private owners with the approval of the price by the Department of Public Utilities. The bill provided that either whole plants or such parts as communities may need may be bought. The Senate adopted the bill with amendments permitting appeal to the courts from findings and decisions of the Department of Public Utilities on questions of fact as well as of law, and conference committees failed to reach agreement. The Massachusetts House accepted a report by the legislative committee on power and light disapproving the proposal that the Department of Public Utilities should have supervision over holding companies.

NEBRASKA.—Petitions asking for the submission to voters at the general election of three additional proposals affecting power and light service are in circulation in Nebraska, and Attorney-General Sorensen, who, as president of the People's Power and Light Association, is backing the original proposal to allow the people to set up light and power districts and to enable city councils to extend municipal plants as far as they please, is charging that these petitions are part of the policy of opposition of power companies and are intended to mislead voters.

NEW YORK. — Addressing the Democratic State Committee at Albany last week, Governor Roosevelt took credit for the legislative steps taken to solve the question of state water power. He added:

> Hand in hand with water power goes the general subject of the control of utilities. I am confident that the Public Service Commission today again is functioning in the purposes for which it was originally organized under Governor Hughes in 1907. This is not enough. New theories and new business practices have grown up, so that now many utilities claim the essential right to earn far more than a reasonable rate of return on their investment. They have tried to wipe out any distinction between a public utility and a wholly private corporation engaged in wholly private enterprises. They seek in many instances to earn not 7 or 8 per cent but 30, 40 and 50 per cent on a large portion of their investment.

OREGON.—The Oregon Supreme Court has upheld against attack the legality of the ballot title which was written by the State Attorney-General for the initiative petition providing for constitutional amendments intended to enable municipalities and counties to acquire and operate water and electric utilities.

The Republican nominee for Governor, George W. Joseph, has pledged himself if elected, to try to bring about the discontinuance of state regulation. A petition for a vote on an initiative law for this purpose is being circulated, but the Attorney-General says it does not comply with the legal requirement.

WISCONSIN.—A plank on public utilities adopted June 11 at the Republican state convention in Wisconsin says: "We do not believe in the wisdom or efficiency of state ownership. We do believe that, properly administered, the present system of regulation and controlled monopoly will result in better and cheaper service to the people. We recommend, therefore, that the regulatory laws and organization of the state be enlarged and strengthened." The platform adopted by the state Democratic party indorses state ownership and control of water powers, demanding legislation to restore competition and to give the right to municipally owned utilities to fix their own rates and to provide methods for extensions in and beyond corporate limits.

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Coming Meetings

Wisconsin Utilities Association—Electric Section, Lorain Hotel, Madison, July 17 and 18. Commercial Section, Green Bay, July 31 and Aug. 1. J. N. Cadby, 105 Wells St., Milwaukee.

Camp Co-operation X—Association Island, Henderson Harbor, N. Y. July 31-Aug. 4. Society for Electrical Development, 420 Lexington Ave., New York.

Association of Electragists International—Hotel Schroeder, Milwaukee, Aug. 18-20. L. W. Davis, 420 Lexington Ave., New York.

International Association of Electrical Inspectors—Northwest Section, Bellingham, Wash., Aug. 25-27. F. D. Weber, 414 Lumbermen's Bldg., Portland, Ore. Western Section, Congress Hotel, Chicago, Ill., Sept. 15-18. W. S. Boyd, 175 Jackson Blvd., Chicago. Eastern Section, Pittsfield, Mass., Sept. 22-24. R. Walker, 85 John St., New York.

American Institute of Electrical Engineers — Pacific Coast convention, Portland, Ore., Sept. 2-5. F. L. Hutchinson, 33 West 39th St., New York.

Pennsylvania Electric Association—Bedford Springs, Pa., Sept. 3-5. Harold A. Buch, Telegraph Bldg., Harrisburg, Pa.

Empire State Gas and Electric Association—Saranac Inn, N. Y., Sept. 18 and 19. C. H. B. Chapin, Grand Central Terminal, New York.

Great Lakes Division, N.E.L.A.—French Lick Springs, Ind., Sept. 25-27. T. C. Polk, 20 North Wacker Drive, Chicago.

New England Division, N.E.L.A.—New Ocean House, Swampscott, Mass., Sept. 29-Oct. 1. Miss O. A. Bursiel, 20 Providence St., Boston.

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Kansas City, Kan., Rejects Bid for Plant

UNANIMOUS rejection by the Mayor and City Commissioners of Kansas City, Kan., in session on June 18, met the proposal of Nathan L. Jones, utility promoter of Salina, Kan., that a special election be called on his bid of $7,000,000 for the municipal generating plant of the city first named (ELECTRICAL WORLD, June 14, page 1188). The City Clerk returned the check for $100,000 posted by Mr. Jones, who, saying that the future course of his company in the matter was undecided, added: "We certainly do not want the property if we cannot have the good will of the people."

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Steam-Locomotive Builder Predicts Electrification

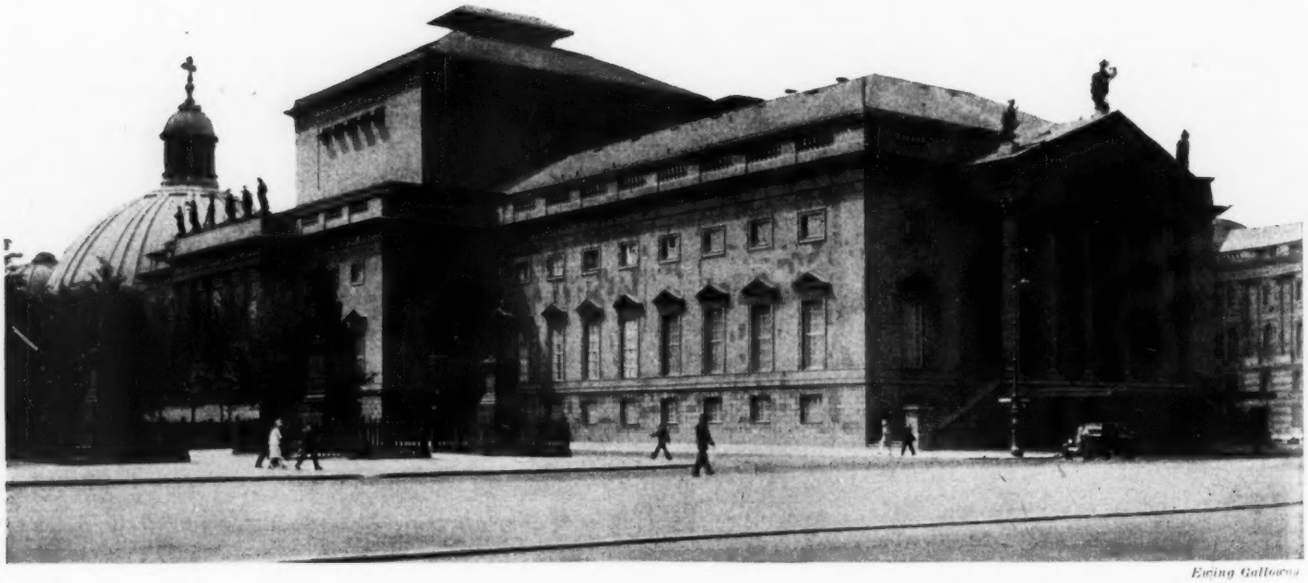
WHILE insisting that the steam locomotive has still a growing task to meet and will be in full service fifty years hence, Samuel M. Vauclain, chairman of the board of the Baldwin Locomotive Works, made a prediction before members of the American Railway Association in Atlantic City on June 24 that the electric operation of railroads from Boston to Washington was sure to be realized.

"Since approximately 40 per cent of the population of the United States is east of the Alleghany Mountains, I can see no reason why such electric operation would not be more economical and satisfactory than steam," he said.

Ewing Galloway

World Power Conference

THE second World Power Conference was held in Berlin, June 16-25. It was inaugurated by a reception in the Reichstag Building (above) and consisted of a discussion of 400 papers from all countries in the Kroll Opera House (below). A special report of the conference is presented in this issue of *Electrical World*.



Ewing Galloway

EDITORIALS

L.W.W.MORROW
Editor

The World Power Conference—A Disarmament Treaty

THE Berlin World Power Conference is over. It was a success from the rise of the curtain until the last inspection trip was completed. It has become a powerful international agency and is welcomed to a seat near the throne of each government represented.

To what ends may it be developed? It will be accepted as a means to exchange knowledge on the technical and economic aspects of world power supply, but it has far greater tasks and obligations. Law, religion and philosophy throughout history have attempted to combat the ills arising from the disharmonies of human beings. They have attempted to cure the maladies that mar human existence. A measure of success has been met in meeting physical ills and setting up governmental institutions, but times have changed and conditions are more complex.

The modern world is in the clutches of science and scientific applications. It works as a mechanism does, with human capacity multiplied many times by power and human efforts co-ordinated by forces that call for mass production and a machine age. Science has given man-power heretofore undreamed of and almost uncontrollable. Can science cure the ills of the modern civilization it nurtures and will it join with religion, law and philosophy for this humanitarian purpose?

Science and its applications call for the abandonment of much that is habitual and traditional and create a revolution in the mode of education, of business and of labor. Can the scientists and engineers redress the disharmonies they create and can they bring about the improvement and solidarity of mankind?

Striking hard at this thought, is not the World Power Conference a most vital agency to consider these broad and humanitarian questions that so disturbingly confront the nations of the world? In the program at the conference, in addresses presented and in personal and group contacts a strong feeling of obligation to civilization was manifest. Beyond doubt those in charge of the conference in all countries feel the necessity for a discussion of the social aspects of power supply and use. Beyond a doubt they feel that the World Power Conference should become an agency to help bring about international wellbeing and should adopt a policy and a program for the improvement of civilization in each nation. This is the hopeful aspect and the dominant possibility of world power conferences. They should help harness and control science for the benefit of mankind.

Duplexing Possibilities with Electric Furnaces

THE "duplex" process for the continuous production of malleable-iron castings is gaining ground. It is economical because it eliminates the inherent slowness of batch operation which cupola melting imposes. An electric furnace which can melt down only three tons of cold metal can hold twelve to thirteen tons of melted iron and can raise the heat if desired. A duplex installation, consisting of cupolas to make the initial melt and electric furnaces to take the cupola batches and refine them and then to make as frequent pours as are necessary for continuous production of castings, is thus an almost ideal production unit.

The maximum capacity of the electric furnace as a refining medium can be utilized, leaving the rather crude job of the initial melt to the cupola or to the blast furnace, to be used in steel as in malle-

able-iron casting. The trouble is that very few steel foundries have an output large enough to permit consideration of continuous production economy to enter the picture.

It would be unjustified to say that the production of electric steel castings is small because the price of them is high. As a matter of fact, the production is really large considering the newness of the art. But there still remains untouched a vast field in which alloy steel castings with definite properties of tensile and compressive strength, of rust and heat resistance and of appearance might be used. This field will not be invaded in force until the foundries make full use of the electric furnace as a component part in duplexing and similar processes, thus profiting from the continuous straight-line production schedule that has lowered costs in so many other industries.

No Money for Municipal Distribution

SINCE the city of San Francisco completed its municipal power plant in connection with the Hetch Hetchy domestic water supply, five years ago, there has been a constant clamor for the city to buy out the two existing private systems and go itself into the retail electricity business. At the time the city's plant was completed it had no means of disposing of its power and as an expedient contracted to sell energy to one of the private companies. Since that time the city has been receiving approximately $2,000,000 a year for its power, which has gone to redeem bonds and reduce the tax rate. In the meantime the city authorized the Railroad Commission to make a valuation of the two existing private distribution systems. The commission's figures for the two were $68,115,000, but the city engineer wisely points out that it will take $85,000,000 instead to put the city into the power business.

As an outgrowth of all this San Francisco finds itself in a peculiar predicament. There is a margin of only $89,000,000 left in its bonding limit, and if $85,000,000 of power bonds were voted there would be no money left for the many civic enterprises needed. Moreover, the city is talking of spending fifteen to twenty-five millions to buy out the competing privately owned street-car system. If a bond election is not held, the city will show bad faith in the valuation proceedings and will have to defray the cost of the valuation, which was some $500,000. In an effort to find a way out and to save the $500,000, the Board of Supervisors has authorized placing a $68,115,000 bond issue before the voters at the August primary election. The board frankly admits that this amount is insufficient to set up a municipal distribution system, but it does not have the temerity to ask the full $85,000,000.

The larger bond issue would undoubtedly fail, as will likely the smaller one also. What the next move will be no one knows. If the city did take over its distribution system it would gain nothing; it would simply replace private capital with its own credit and reduce its bonding limit to the point where civic stagnation would set in. The wise thing for the city to do, of course, is to let the bond issue fail and then devote its attention to city government and let private capital operate specialized industry.

A Psychological Problem Confronts Engineers

ACCORDING to experience in the electric service field, people are becoming more sensitive to noise and are exacting requirements not formerly imposed. Possibly it is the nervous reaction caused by the present business pace. Possibly it is the combined effect of more congested living conditions, increased traffic noises and an indifferent use of loudspeakers.

In any event there is a noticeable resentment against any new sources of noise. Utilities are observing this trend wherever the vibrations of electrical equipment or ventilating equipment occur in proximity to residences. The lamination or ventilation hums of substations may not be offensive where residences have grown up around the installations, but they seem to be unbearable to some persons when new substations are installed in their neighborhood.

Extreme precautions have been taken by some companies to prevent the spread of these noises by installing isolated foundations, avoiding windows, venting exhaust air above the elevation of surrounding buildings, etc. When it comes to outdoor installations, made chiefly to minimize investment and thus keep down rates of energy, the problem has been more difficult because of absence of inclosures. In desperation utilities have specified elimination of noise in their purchase requisitions and some improvements have been made. But manufacturers claim that complete elimination of noise will make the price of equipment prohibitive.

Considering the noise emanating from any one of the variety of sources now existent, the hum of electrical equipment seems almost insignificant. But noise sensitivity will increase rather than decrease and manufacturers will be forced to take all reasonable precautions to avoid objectionable vibrations. In developing preventive or remedial measures, existing psychological studies of noise audibility can be drawn upon. The instruments developed by the Bell Telephone Laboratories for analyzing the quality and quantity of complex vibrations should be very helpful in detecting the sources of irritating noises.

It is a tribute to utilities' consideration of public attitude that they are jointly analyzing the solution of this problem. Methods used to stifle noise from different equipment should be widely disseminated.

Possibilities of Grid System in America

THE establishment of the "grid system" in England is attracting world-wide attention. The present scheme does not involve the purchase of either generating stations or local distribution systems. In essence, the grid will serve only as a middleman, receiving electrical power from various sources at stated rates, and wholesaling this power to distributing agencies at an advance in price to cover the costs of transmission and administration.

Since provision is made for receiving and marketing dump or by-product power, the question arises whether this plan can be applied in the United States to supplement existing intersystem ties. One of the nearest approaches to the English grid system is the Connecticut Valley Power Exchange.

Some public utility executives may feel that all commercial possibilities of this sort have already been thoroughly analyzed and developed. Yet one hears of blast-furnace plants with waste gas, cement mills with waste heat and coke ovens with waste braise which are not being utilized at the moment.

Some will hold that the acceptance of by-product power by a transmission system does not relieve the generating plant of the necessity to provide equipment to meet the system peak when no by-product power is available. This is generally true if such by-product power is available from one or two sources only. However, if this is available from many sources, and if the firms that supply such excess power may at other times absorb power from the transmission system, the natural diversity which normally distributes demands with an industrial load will come into play and will equalize supply and demand of this excess power.

Prices paid for power supplied to, and taken from, the transmission system can be adjusted so that a profit may be made by the utility above the costs of furnishing the interconnecting transmission services.

This class of service could be furnished in many cases at little additional cost, for high-voltage distribution systems are generally found in the industrial districts of most cities. Excess by-product power from process steam in certain industries, from waste heat in others and from wastes or low-grade fuel would constitute the main sources of supply. This energy would be available on all working days, when, in general, power loads are heavy. On Sundays and holidays the by-product power furnished to the system would be small, but loads would also be small. Hence such additions to a system should not disturb the present generating plant.

In view of the tendency of large users of electricity to consider the generation of their own power, this plan might well be given close study in highly industrialized areas.

Berlin Conference Stimulating

Nearly 400 papers presented at World Power Conference. Engineering, economic, administrative and social aspects of power supply discussed. International rationalization proposed

By L. W. W. MORROW
Editor ELECTRICAL WORLD

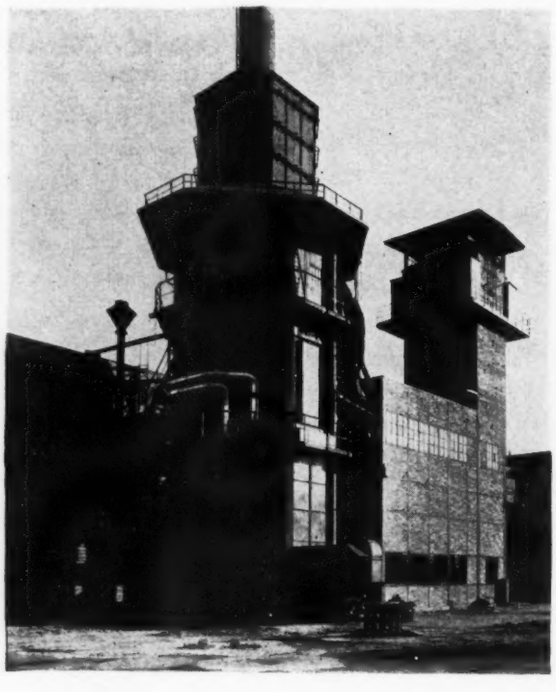
By Special Cable to ELECTRICAL WORLD

TRAVEL-WEARY delegates to the World Power Conference in Berlin on June 16-25 arrived with great expectations. These were more than met. The program at the conference, the Hindenburg reception in the Reichstag Building, the gala dinner, with Ambassador Sackett as an honor guest and speaker, and the lavish entertainment and hospitality of Berliners showered the visitors with mental and physical pleasures.

A veritable tower of Babel existed at the Hotel Adlon headquarters, but the 200 visitors from the United States united with British Empire delegates to give an English language flavor to the pot pourri. Power specialists, utility executives, politicians, publicists, reporters, economists and professors from all parts of the world mingled together to exchange knowledge and get acquainted. The cause of power in all its social, economic and technical aspects was advanced marvelously under the stimuli derived from the meeting. Truly the world is becoming power minded and the World Power Conference is established as a potent agency for establishing international rationalization in power activities. It may well become a centripetal force to bind nations together in friendship and comity. The program afforded ample evidence that science, the youngest child of knowledge, has begun to investigate the great problems affecting humanity.

It is impossible to report the conference in a brief account. More than 400 papers in many languages were prepared for the technical meetings, including 57 by American authors. At least a dozen general addresses were given on topics ranging from pure science to international friendships. The 34 sections of the conference met in three or four parallel sessions each day to hear the summary of the formal papers and to discuss them. An unusually effective arrangement of headsets and radio systems permitted the discussion to be heard in any of three languages. The record of the conference will fill one or more large volumes and will be available in a few months.

The whole world has become interested in power. It has felt the need for co-operation and the interchange of knowledge about the technical, economic, social and business aspects of power. These are the reasons for the World Power Conferences.



Benson 3,000-lb. pressure steam generator

Science has no boundaries to its interests and its applications and the scientists and engineers must know what all the world is doing and thinking. New ideas, new methods and more modern points of view must be assimilated as rapidly as possible. Barriers of language, national psychology and the absence of personal contacts must not close the books of knowledge to engineers and scientists. Through the common interest in the development of power the world is one country.

The 100,000-hp. development on the River Inn in Bavaria is a part of a planned program for national power development

Ewing Galloway

Leaders in international power development had this conception when the first World Power Conference was held in London in 1924. Since that date various limited aspects of the international power problems have been discussed at sectional meetings; at Basle in 1926 water power was discussed, at London in 1928 fuel problems were discussed, at Barcelona in 1929 water power was discussed, at Tokio in 1929 general power problems were discussed. The initial movement of 1923 has found a worldwide welcome, and the second plenary conference in Berlin was the culmination of years of growth and indicated the value and scope of an international power conference. It showed that the world is trying to get an adequate and economical power supply. It is trying to economize, it must get the maximum out of each pound of coal, each gallon of oil and each drop of water, it must use capital wisely and reduce operating expenses and, beyond this, it must so bend its civilization, based on power use and the use of machines, that human welfare will be attained and the world be made a better place to live in. This is the background for the program presented at Berlin.

The Berlin conference was under the sponsorship of President von Hindenburg, with Dr. Oskar von Miller as honorary president and Dr. Edward Tissot as chairman. It began with a reception in the Reichstag Building on the evening of June 14, where delegates from all nations were welcomed to Germany. Special topical meetings were held during the morning and evening of meeting days and the climax was a dinner on June 18, at which addresses were given by men with international reputations. The United States was represented by about 200 at the conference and contributed greatly to the program. The work of the American committee, with O. C. Merrill as chairman, proved that a permanent organization was warranted and welcome.

The program of the conference contained 389 formal papers on economic, technical and social aspects of power, and of these 57 were contributed by the United States. In addition scientific and economic addresses were given by leading international scientists such as Dr. Einstein, Professor Eddington and Dr. Oliven. To these must be added the significant discussions by Ambassador Sackett and other international political figures.

The conference was divided into 34 sections, with parallel meetings for the discussion of the formal papers, only a summary of which were presented. The discussions at the meetings were prepared in advance, limited to 50 words each and given in three languages. As a result the discussions amounted to very little. The heart of the conference lies in the formal papers, and these will be published and made available soon. The conclusion is inevitable that the number of papers was too large and the barriers of language too great to expect much informal discussion at the technical meetings. This handicap was overcome by the use of informal group meetings of interested specialists and by the personal contacts made possible by the conference.

A feature was an address by Dr. Einstein on the significance of his new field theory in relation to existing concepts of space and time.

Professor Einstein traced the development of ideas about geometry and space. He stated that it is illogical to rely upon the senses and their reaction for building up a theory of the physics of the universe, yet granted that since men are human all theories must be based in some degree upon sense experiences in the early days. The finite world of solid bodies formed the basis of the first attempt to reduce sense experiences to a logical system.

World Power Topical Program

Monday, June 16

Electricity in the Household and in Agriculture.
The Production, Preparation and Use of Solid Fuels.
Problems Relating to Water Rights.
Address by Dr. Albert Einstein.

Tuesday, June 17

Electricity in the Crafts and Industry.
Fuel, Power and Heat Economics in Individual Countries.
Research Work.
Address by Dr. Serruys on Rationalization.
World Problems of Power Supply.
Standardization Problems and the Rationalization of Statistics.
Education.

Wednesday, June 18

Three Dimensional Load Models and Current Rates.
Economic Problems of High-Temperature Distillation.
Power Supply on Ships.
Gas Markets.
Power Supply in Individual Countries.
Mechanical Transmission of Power on Vehicles and in Factories.
Address by Ambassador Sackett, "The American Hour."
Address by H. F. Bain, "Place of Minerals in a Power-Sustained World."
Official World Power Conference banquet.

Thursday, June 19

Construction and Operation of Large Industrial Power Plants.
Automobiles and Aircraft Engines.
Construction of Large Electrical Machinery.
Legislation and Public Control of Gas and Electricity Supply.
Production of Natural and Synthetic Oils and Properties of Motor Fuels.
Address by Dr. Oliven, "Europas Grosskraft-linien."

Friday, June 20

Co-operation of Power-Producing Plants.
Steam and Electric Railways.
The Italian Hour.

Saturday, June 21

The Transmission and Flow of Energy in Networks.
Stationary Internal Combustion Engines.
Dams.

Monday, June 23

Steam Turbines, Gas Turbines and Reciprocating Engines.
Rationalization of World Power Problems.
Economic Problems of Power Storage.
Earthing, Lightning Protection and Co-ordination.
Address by A. S. Eddington, "Subatomic Energy."

Tuesday, June 24

Costs and Efficiencies from Consumers' Viewpoint.
Boilers and Furnaces.
Water-Power Industry in Individual Countries.
Power and Civilization.

Wednesday, June 25

Combined Heat and Power Supply Plants.
Switchgear, Including Remote and Supervisory Control.

The Greeks thought in terms of the relative position of solid bodies and built their mathematics upon a few elements such as the point, the plane, the line, and distance. They dealt with solid objects and their relative positions. To Descartes is given credit for first introducing the idea of continuous space, and this added to Newton's mechanics to make a fairly complete conception of Cartesian space.

Space the only reality

Space became a physical reality. Next came studies of light and the introduction of the concept of ether, and to this was added the destroying influence of the Faraday-Maxwell electromagnetic field theory. These fields could not be included in the Newtonian conception of ponderable matter and ponderable ether. In a final summing up of the development of ideas of space and time Professor Einstein showed how the special theory of relativity established the fact that space and time must be united in a single four dimensional continuum and that reality did not conform with the conception of simultaneous events. No absolute character can be ascribed to speed, to acceleration or to the idea of an inertial system in nature. The complete relativity theory must embrace all Gaussian co-ordinate systems in a four dimensional space. Space loses its absolute character. It is changeable and can be influenced and is analogous in structure to the electromagnetic field. The last bit of substance has been taken from the conception of the ether.

The latest comment of Albert Einstein on relativity may be summarized in the quotation, "Taken together we can say symbolically that space brought to light by material bodies and raised to scientific reality by Newton in the last few decades has swallowed up ether and time and is about to swallow up field theory and corpuscular theory as well so that it will remain as the only theory representing reality."

Professor Eddington

Another splendid address was given by Prof. A. S. Eddington, on subatomic energy. He gave little promise of the practical application of this energy and outlined the several theories extant as regards the make-up of matter and energy. He said:

"An Eldorado of limitless energy exists could man but unlock it from the universe. There is enough energy in a drop of water to furnish 200 hp. for a year and the energy in each particle of matter is of the same comparable magnitude. Einstein has shown how to calculate the energy, but no one has yet gained the power to release it or to control it. But in the universe of the stars subatomic energy is released, else it would long ago have become cold and sterile. Subatomic energy may be released by an actual destruction of matter, and this theory involves the death of electrons and protons through collisions and orbital excitations. Another theory is that subatomic energy is released through the transmutation of the elements. The units within the atom may be rearranged to release energy. None of these radioactive processes yields energy sufficient for practical purposes. There is no exact knowledge to decide between the annihilation and the transmutation theory of atomic energy release."

It appears to Professor Eddington that appreciable quantities of energy could be released if it were possible to heat matter to upward of 40,000,000 deg. (Celsius). Matter seems to have a critical energy boiling point, so to speak. This would be a crude way of releasing sub-

atomic energy, but already Dr. Kapitza has secured energy concentrations corresponding to 1,000,000,000 deg. at the Cavendish Laboratory. But a study of cosmic radiation and the annihilation theory of subatomic energy leads to cold instead of to heat. This phenomena of interstellar space must occur at a temperature below that of liquid hydrogen. Then the riddle is still unsolved. There are many clues, but all are inconclusive. Subatomic energy is in the fog-bound frontier of knowledge only.

Ambassador Sackett

Ambassador Frederic M. Sackett in his address analyzed certain of the factors which give heart to the agitators for government ownership and operation of utility businesses. He especially emphasized the unusually high ratio of delivered cost to production cost of electric energy:

"To state the point concisely, I know of no other manufacturing industry where the sale price of the product to the great mass of consumers is fifteen times the actual cost of production of the article sold. My purpose is sharply to define a weakness that calls for the keenest thought in your deliberations. Until the power business is brought in line with other industries in the relationship of its cost of production to the price paid by the consumer for the product, there can be little justification for thinking that this great power industry is rapidly approaching perfection."

(See also page 1237, ELECTRICAL WORLD, June 21, 1930.)

Prof. Robert Sibley

The history and problems of power development in the most completely electrified farm and home district in the world, California, was brought out in a thoroughly comprehensive paper by Prof. Robert Sibley. Predicating his remarks upon a brief international survey of power production in which the combined kilowatt-hour output of the United States and Canada balance that of the rest of the world, the author outlined the engineering problems involved in the California development. Chief among these were the record-breaking distances, of 250 to 300 miles, over which, in some cases, it was necessary to transmit power at voltages up to 220,000, and an area only 20 per cent smaller than Germany. California's topography and isolation created not only physical difficulties, but also financial problems, the latter having been solved to a large extent by customer ownership of stocks.

It was shown how the solution of these problems influenced the consumption of power in industry, agriculture and the home, the plentiful supply leading to new uses in the canning of fruit, on the farm, and in domestic application. As a result, the use of electricity in California is the highest per capita of any community of equal area.

Ewing Galloway

Koniggratzen Street in Berlin on a busy day

Dr. H. Foster Bain

According to Dr. H. Foster Bain, neither slaves nor animals could ever have made possible our modern life. To accomplish this man needed power that did not compete with him for food, which could be had in quantity and which could be concentrated in large units and directed effectively. Experiment and effort directed to harnessing wind and water were measurably successful, but power as needed was only found when man conquered the mineral kingdom of nature. Coal and its coworker, petroleum, make modern transportation, power and communication possible. The quantity of minerals used in the world is enormous. For example, minerals make up 52 per cent of the freight carried by the railways of North America, and if the derived products are added the percentage mounts to more than 70 per cent. Immense drafts are being made on the world's supply of minerals. Since 1900 more have been used than in all preceding history. In the United States the per capita consumption of minerals has multiplied ten times in forty years and this per capita draft on raw materials is increasing in all parts of the world.

Mineral exhaustion not to be feared

There can be no dispute as to the fact that mineral deposits are exhaustible, but great areas remain about which geological knowledge is missing and many deposits undoubtedly will be found in deeper strata than now explored, so that no present danger exists as to exhaustion of mineral resources. It is a question of technology and price. If the world wants minerals badly enough to pay for them they will be forthcoming. Two trends operate to relieve pressure on mines for new metal and toward stabilization of price. These are the accumulation of stocks in use of metals reclaimable after use, and the ability to make

substitutions in the future. These two trends may operate to give mankind the metals needed with only small additions of virgin metal.

Von Hindenburg expresses world view

President Von Hindenburg in his message said: "On its foundation the world power conference was called the 'technical League of Nations,' and nothing is indeed better calculated to league together the nations of the earth than a mutual endeavor of this kind to further the common weal. Interchange of thought promotes mutual understanding. Moreover, practical progress in the sphere to which your conference is devoted will always lead to closer relations between the nations by developing the transport of power across the political frontiers. Engineering is about to exercise greater influence than ever upon the economic life of the peoples and to establish a closer connection than ever before between their economic systems. You as the leading workers in engineering, science and economy will, by your conference, bring about an appreciative co-operation between the governments and all the different factors of public life and yourselves. The supply of power, light and heat in every new and improved form will prove an effective means of animating economic activity. It will tend to reduce unemployment and thus to counteract the difficulties under which the economics of almost all countries of the world are at present laboring."

Some high lights of the conference

Power problems are international and very similar in all countries. The stages of development and practices differ, but the fundamental conditions remain. In engineering the goal sought is the greater efficiency in the utilization of natural resources. It is apparent that water-power equipment promises little for the future because of its highly developed state, but in the use of fuel and oil much remains to be done. Both Great Britain and Germany are equal to the United States in thermal efficiency accomplishments and in some respects Germany is in advance. Low-grade fuels are used to advantage, high-pressure and high-temperature installations are used and technical researches are well advanced. Nothing very outstanding was brought out at the conference in these respects, but the papers indicated that progress is being made and equipment is being improved. Lightning is a handicap to transmission in all countries and none has reached solutions in greater perfection than those found in this country.

Researches are being carried on everywhere and the pooled knowledge will make for progress. It was apparent that the United States can help the other nations through its experiences with the use of large generating units, through long-distance transmission line construction and through interconnection operations. Many countries are developing national interconnected power supplies similar to those in operation in this country and they were greatly interested in construction and operating practices.

In the economic aspects of power development much interest was exhibited. The sale and use of power to all markets, methods to reduce costs, methods to use fuel and hydro resources efficiently and even methods of organization and finance were of common interest. And much difference in practice and opinion exists. Italy, Germany, Great Britain and Russia each applies a different economic program for power development and each is based on local conditions. Study of the relative principles and practices may lead to some international rationalization. Equally variable are the economic principles applied to power use in factories and industries. Rate systems differ, proposals to rent modern machinery were made, interconnection of industrial plants was suggested—each country has a different economic picture of the machine age and mass production. Of these the experiment of Russia in forcing a man-made economic structure is most interesting.

Administration of power supplies afforded an interesting contrast between countries. Each nation recognizes a public interest in power supply and has reached an individualistic solution. In Russia it is a governmental function, in Great Britain the Central Electricity Board scheme is an interesting innovation to get semi-governmental control and ownership into a complex situation. In Germany both the government, municipalities and private enterprise are joined to power supply in many different forms. So each nation is trying to get a national power supply by handling its own conditions on a basis that will get results. No conclusions can be made except that all work out to get results, and truly rapid strides are being made in all industrial countries. Apparently the form of organization and the internal organization set-up are non-essential if intelligent leadership is had, but in a few years it should be possible to bring about some degree of rationalization.

Education and promotion of power use is another dominant aspect of the conference. Each country finds it necessary to teach the public about electric power supply and to tell of its effects on civilization. Each country has a marketing problem in that it must get old methods and equipment discarded and new methods and equipment used. Many of these countries find their industries in no financial condition to finance these changes; in others the purchasing power of the public is very small and so many variables occur that each region becomes a particular problem in sales study and sales promotion. Remarkable progress is being made and the conference bore unmistakable evidence that selling now ranks with engineering.

Power has sociological bearing

And beyond these problems, that may be called internal to the power industry, there came a note of vision and breadth very encouraging to the world. Stress was placed upon the fact that beyond the mechanics of power supply, machinery use and mass production lie social problems of great significance. Capital, labor and power are now the big three that must pull together in the world. The machine age must be built—yes, but it must be so constructed that it give an improved civilization and produce a permanent civilization that is better than those recorded in history.

The conclusion is inevitable that the World Power Conference is a worth-while international effort. It deals with tangibles, with economic, engineering and social problems common to all countries, with assets that each nation needs and can use. It is a big meeting and it must be kept broad and international in flavor and scope. The Berlin conference will have a decided influence upon the world, and those responsible for it and for the program presented are to be commended.

Steam Turbines for Power

THE steam turbo-generator dominates in electric power production. In this paper Professor Christie has compiled complete data on present American turbo-generator practice. He outlines developments and indicates trends. Especially noteworthy are economic data, a new analysis of reheating and a method for rating turbine casings. Contributions were made to the paper by all American turbine manufacturers except the General Electric Company, one of whose engineers presented a paper on turbo-generators to the World Power Conference.

By A. G. CHRISTIE*

Johns Hopkins University

THE economic basis for the application of steam turbines to power generation may be either rate of growth of load, first cost, operating cost, maintenance cost, high thermal efficiency, reliability, concentration of capacity, size of unit and many other items inherent in this power-generating device.

The efficiency of a given type and size of turbine is limited by competition. This results in low first cost, but not maximum efficiency. The trend is toward units of large capacity because economies may be had, space factors reduced and large power loads handled. No general rule can be given as to size of unit for a particular plant. The art is developing rapidly, loads are growing and reliability factors changing—all must be evaluated for a given system.

Turbines are now generally selected on the basis of average annual use factor over their working life. Engineers prefer to use no special machines for base loads or for peak loads. Added furnace volume is believed to be the cheapest method for carrying peak loads with added capacity in turbines or the use of high-pressure turbines for peak service.

The amount of reserve capacity for a system is a variable. Some general rules are: Sufficient reserve to

(Text continued on page 1330)

**Based on paper entitled "Economic Considerations in the Application of Modern Steam Turbines to Power Generation," World Power Conference, Berlin, June 16-25, 1930.*

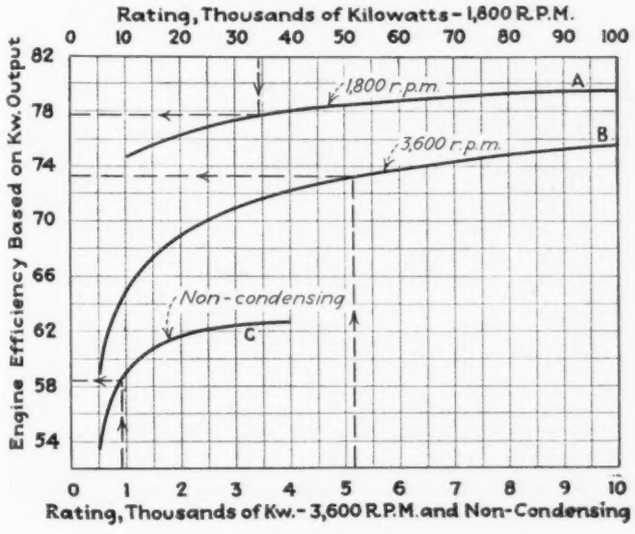

Rating, Thousands of Kilowatts - 1,800 R.P.M.
0 10 20 30 40 50 60 70 80 90 100
Engine Efficiency Based on Kw. Output
82 78 74 70 66 62 58 54
1,800 r.p.m.
A
3,600 r.p.m.
B
Non-condensing
C
0 1 2 3 4 5 6 7 8 9 10
Rating, Thousands of Kw. - 3,600 R.P.M. and Non-Condensing

Fig. 1—Average engine efficiency for the load point of best efficiency based on kilowatt output at the generator terminals

Curve A—1,800-r.p.m. turbines for steam conditions up to 450 lb. per square inch gage (32.7 atm.), 750 deg. F. (400 deg. C.), 29-in. vacuum (0.0344 atm.).

Curve B—Single-cylinder turbines at 3,600 r.p.m., for steam conditions up to 300 lb. per square inch gage (22.1 atm.), 600 deg. F. (315 deg. C.), 28.5-in. vacuum (0.0516 atm.).

Curve C—Non-condensing units for steam conditions up to 250 lb. per square inch gage (18.6 atm.), 550 deg. F. (288 deg. C.), atmospheric pressure at exhaust.

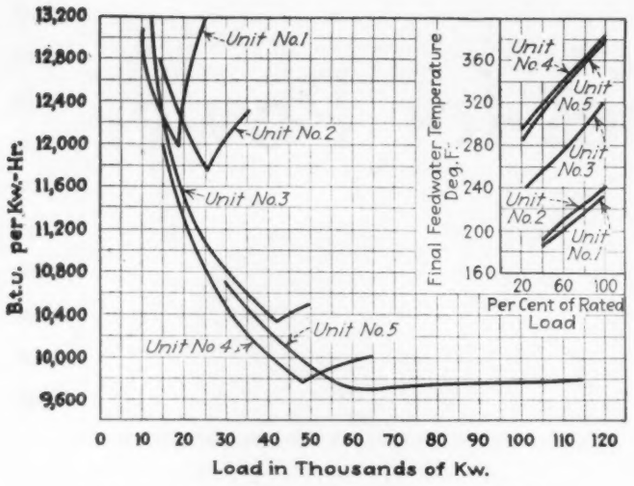


Fig. 2—Improvement in steam turbine performance

The economy characteristics of a series of five units installed and building for a typical American central station during a period of eight years, from data furnished by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Final feedwater temperatures at various per cents of rated load are also shown.

Unit No. 1—25,000 kw. at 93 per cent power factor. Operating conditions—350 lb. per square inch gage (25.6 atm.), 675 deg. F. (357 deg. C.), 29-in. vacuum (0.0344 atm.), two-stage bleeding. Installed in 1923.

Unit No. 2—35,000 kw. at 93 per cent power factor. Operating conditions—350 lb. per square inch gage (25.6 atm.), 675 deg. F. (357 deg. C.), 29-in. vacuum (0.0344 atm.), two-stage bleeding. Installed in 1925.

Unit No. 3—50,000 kw. at 85 per cent power factor. Operating conditions—600 lb. per square inch gage (43.2 atm.), 725 deg. F. (385 deg. C.), 29-in. vacuum (0.0344 atm.), four-stage bleeding. Installed in 1927.

Unit No. 4—65,000 kw. at 85 per cent power factor. Operating conditions—600 lb. per square inch gage (43.2 atm.), 725 deg. F. (385 deg. C.), 29-in. vacuum (0.0344 atm.), reheat to 725 deg. F. (385 deg. C.), four-stage bleeding. Installed in 1930.

Unit No. 5—115,000 kw. at 95 per cent power factor. Operating conditions—625 lb. per square inch gage (45 atm.), 750 deg. F. (400 deg. C.), 29-in. vacuum (0.0344 atm.), reheat to 750 deg. F. (400 deg. C.), four-stage bleeding. To be installed in 1931.

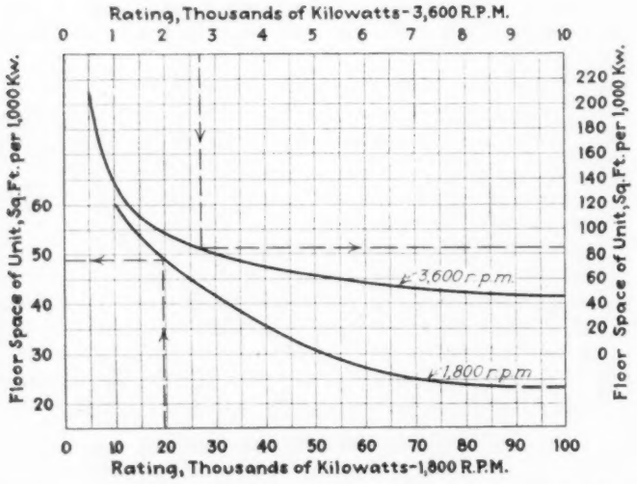


Fig. 3—Floor space required for single-cylinder, 3,600-r.p.m. turbine alternators and single-cylinder, 1,800-r.p.m. units

This area consists of a rectangle-inclosing turbine, generator and direct-connected exciter with an added rectangle for any offset valve gear.

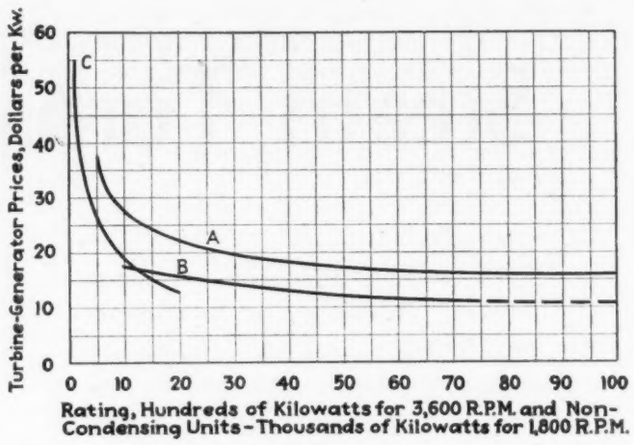


Fig. 4—Prices for turbo-generator units in the United States

Prices include bare turbine and generator without auxiliary generators or direct-connected exciters and are for units delivered and erected. Prices are for pressures up to 400 lb. per square inch gage (29.2 atm.), steam temperatures up to 725 deg. F. (385 deg. C.), and when condensing up to 29-in. vacuum (0.0344 atm.).

Curve A—3,600 r.p.m., condensing units.
Curve B—1,800 r.p.m., condensing units.
Curve C—Small non-condensing sets.

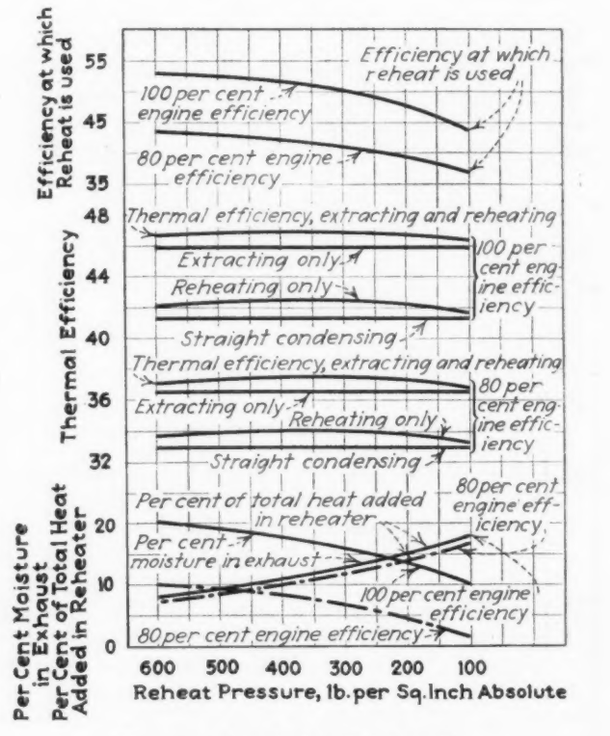


Fig. 5—Analysis of reheating

Initial conditions at the throttle valve of 1,200 lb. per square inch absolute (84.4 atm.), 800 deg. F. (427 deg. C.), and reheating at various pressures to 800 deg. F. (427 deg. C.), with final expansion to 29-in. vacuum (0.0344 atm.) for an ideal turbine of 100 per cent engine efficiency at the coupling and for one with 80 per cent engine efficiency. No allowance made for reheat factors, moisture correction or pressure drop through reheater. (See Fig. 8 for definitions of efficiency, etc.)

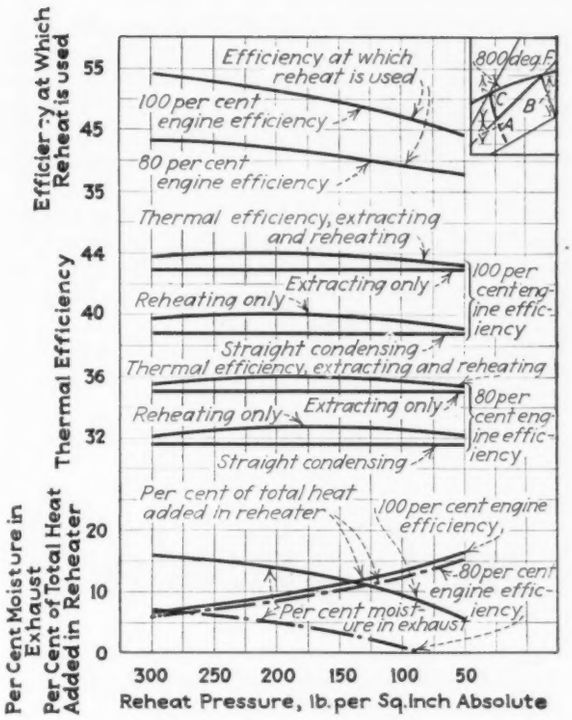

Efficiency at which Reheat is used
Thermal Efficiency
Per Cent Moisture in Exhaust
Per Cent of Total Heat Added in Reheater
Efficiency at which reheat is used
800 deg. F.
100 per cent engine efficiency
80 per cent engine efficiency
Thermal efficiency, extracting and reheating
Extracting only
Reheating only
Straight condensing
100 per cent engine efficiency
Thermal efficiency, extracting and reheating
Extracting only
Reheating only
Straight condensing
80 per cent engine efficiency
Per cent of total heat added in reheater
100 per cent engine efficiency
80 per cent engine efficiency
Per cent moisture in exhaust
Reheat Pressure, lb. per Sq. Inch Absolute

Fig. 6—Analysis of reheating

Initial conditions of 600 lb. per square inch absolute (42.1 atm.), 800 deg. F. (427 deg. C.), and reheating at various pressures to 800 deg. F. (427 deg. C.), with final expansion to 29-in. vacuum (0.0344 atm.) for an ideal turbine of 100 per cent engine efficiency at coupling and for one with 80 per cent engine efficiency. No allowance made for reheat factors, moisture correction or pressure drop through reheater.

Thermal efficiency

$$= \frac{\text{work done in high-pressure section + work done in low-pressure section}}{\text{Heat added by boiler and by reheater above heat of liquid at feed temperature.}}$$

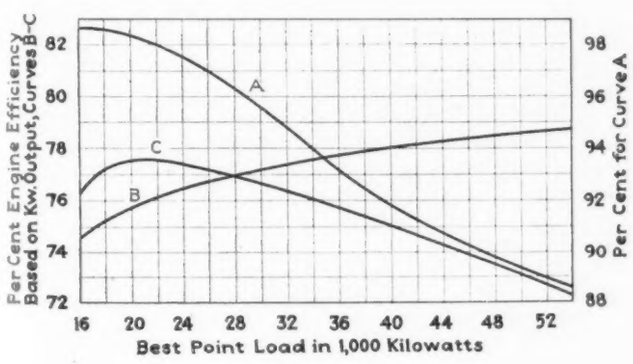
Efficiency at which reheat is used

$$= \frac{\text{Work from steam after reheating — work between same pressures with no reheating}}{\text{Heat added in reheater.}}$$

$$= \frac{B - A}{C} \text{ in Mollier diagram in upper corner of this figure.}$$

Per cent total heat added in reheater

$$= \frac{\text{B.t.u. added in reheater}}{\text{B.t.u. added in boiler above heat of liquid at feed temperature + B.t.u. added in reheater.}}$$



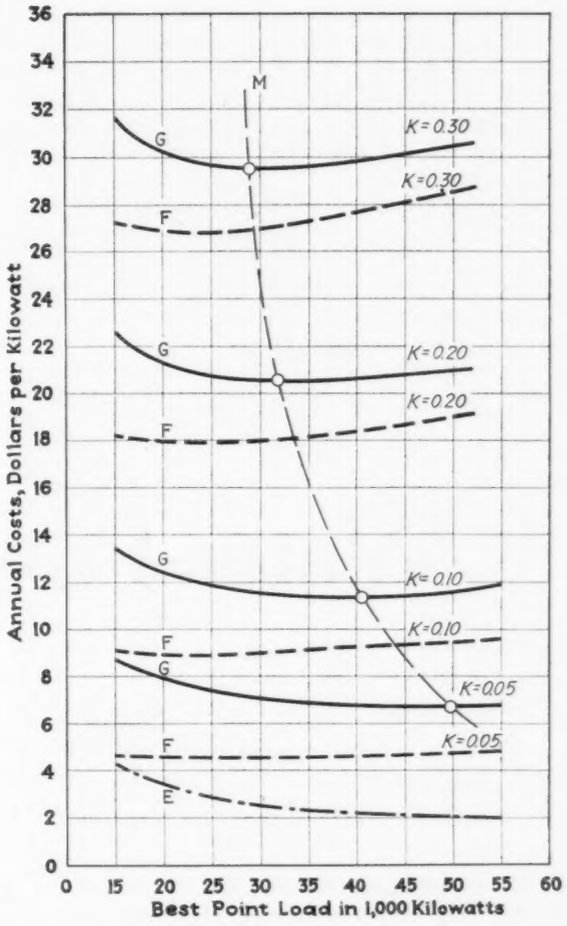


Fig. 8—Fixed charges, annual operating costs and total annual costs for turbo-generator

Refers to Fig. 7 with varying use factors and steam costs plotted against various ratings. This reaction turbine has a last blade annulus of 57 sq.ft. (5.3 sq.m.).

Curve E—Annual fixed charges in dollars per kilowatt, based on 17 per cent of the first cost of turbine-generator installed and including piping and foundations.

Curve F—Annual operating costs for various values of the product of use factor and costs per 1,000 lb. (454 kg.) of steam. Operating costs are based on the average load carried with an average steam consumption 2½ per cent higher than that calculated for the given load from data on Curve C, Fig. 7. Hence annual operating costs = Steam consumption in pounds per kilowatt-hour at given load as calculated from data on Curve C, Fig. 7 ÷ 1,000 × 1.025 × cost of steam per 1,000 lb. × use factor, × 8,760.

Curve G—Total annual costs = Curve E + Curve F for each value of K.

Curve M—Loci of minimum values of G for various values of K.

Fig. 7 (at left)—Performance at various ratings of an 1,800-r.p.m. reaction turbine generator

Fifty-seven sq.ft. (5.3 sq.m.) of last blade annulus with high-pressure blade area proportioned to steam flow.

Operating conditions—300 lb. per square inch gage (22.1 atm.), 620 deg. F. (326 deg. C.), 29-in. vacuum (0.0344 atm.).

Curve A = 100 per cent — per cent leaving loss.

Curve B = Engine efficiency based on kilowatt output exclusive of last rows.

Curve C = Engine efficiency based on kilowatt output of whole turbine.

carry the load when the largest unit is off, two largest units 10 per cent of system capacity, and even any entire station on a system. Load conditions and interconnections modify general rules. Turbines are available about 90 per cent of the time, according to latest records, and a development in blade design and construction promises to improve this remarkable performance.

The trend toward higher steam pressures and temperatures is based on better economic values and thermal performance. The 1,200-lb. plant now costs only about 5 per cent more than the 450-lb. station. The initial steam temperature value apparently is limited to about 750 deg. F.

Regenerative cycles and reheating are general practice in large units and the live steam reheater is gaining in favor. Analyses show that it is economical to bleed superheated steam to heat feedwater, that maximum thermal efficiencies with extracting and reheating occur with reheat pressure ratios of 30 per cent of the initial pressure at 80 per cent turbine efficiency and that reheating has many practical as well as theoretical advantages that can be utilized.

Data on efficiencies of turbo-generators indicate an improvement is made each year. The largest single cylinder, 3,600-r.p.m. turbine in America is a 15,000-kw. high-pressure unit, but single-cylinder machines up to 75,000 kw. have been built for 1,800 r.p.m.

Nothing on the horizon indicates that anything will replace the steam turbine as the chief source of electric power generation.

▼ ▼ ▼

Water Power in Canada

Invested capital over one billion. More than 20,000,000 hp. available. Average investment $219 per horsepower

By J. C. SMITH and C. V. CHRISTIE*

THE water power available in Canada totals 20,347,400 hp. of 24-hour firm power or 33,617,200 hp. of 24-hour power ordinarily available for six months of the year.

The construction of storage dams and reservoirs above the power developments has made it economical to develop many rivers beyond the capacity estimated under ordinary six months' flow and conditions will tend to improve in this respect. The total of 33,617,200 hp. is very conservative as an estimate of the total resources of Canada and when the numerous large and at present almost unknown rapids and falls are surveyed and the necessary storage reservoirs are constructed this total may well be doubled.

The installation for the whole of Canada averages 583 hp. per 1,000 population. Quebec leads the other provinces with 956 hp. per 1,000, British Columbia is second with 948, Ontario is third with 599 and Manitoba is fourth with 470 hp. per 1,000. Nova Scotia has developed 85 per cent of the recorded power available, while Quebec has developed only 20 per cent of horsepower.

The installed turbine capacity in Canadian hydroelectric generating stations in November, 1924, was 3,900,000 hp., while in 1929, five years later, it was 5,700,000, representing an average increase of 360,000 hp. per year. This average rate of installation will probably be increased in the next five-year period and plants now under construction or definitely projected will bring the total installation in 1934 above 7,500,000 hp.

That steam plants play a relatively unimportant part in the supply of electricity throughout Canada in general may be seen from the fact that their combined capacity is less than 5 per cent of the capacity of the hydroelectric plants and they supply less than 1½ per cent of the kilowatt-hours consumed in the country.

The total outstanding capital invested in water-power development, including transmission and distribution, from reports of the Department of Trade and Commerce is $1,172,600,000, which is an average of $219 per horsepower installed. This amount may be subdivided as follows:

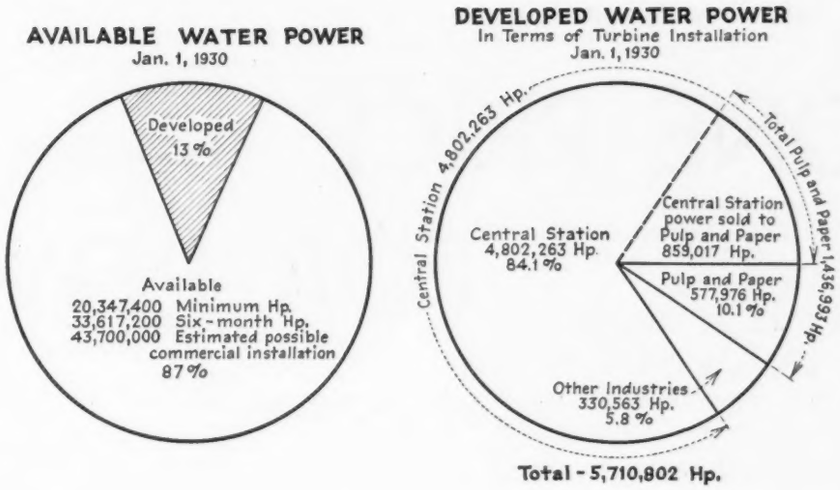
	Per Cent	Per Horsepower
Generation	69.5	$152.00
Transmission	16.0	35.00
Distribution	9.0	20.00
General	5.5	12.00

Table I—Available and Developed Water Power in Canada, October 1, 1929

Province	Available 24-Hr. Hp. at 80 Per Cent Efficiency	Turbine Installation	Population June 1, 1929	Total Installation per 100 Population
British Columbia	5,103,500	560,042	591,000	948
Alberta	1,049,500	70,532	646,000	109
Saskatchewan	1,082,000	35	866,700	...
Manitoba	5,344,500	311,925	663,200	470
Ontario	6,940,000	1,939,675	3,271,300	599
Quebec	13,064,000	2,572,418	2,690,400	956
New Brunswick	169,100	112,131	419,300	267
Nova Scotia	128,300	108,406	550,400	197
Prince Edward Island	5,300	2,439	86,100	28
Yukon and N. W. territory	731,000	13,199	12,400	1,063
Total for Canada	33,617,200	5,710,802	9,796,800	583

**Based on paper "Generation, Transmission and Distribution of Electricity in Canada," World Power Conference, Berlin, 1930.*

Utilization of water-power resources in Canada
(World Power Paper by J. T. Johnston)


AVAILABLE WATER POWER
Jan. 1, 1930
Developed 13 %
Available
20,347,400 Minimum Hp.
33,617,200 Six-month Hp.
43,700,000 Estimated possible commercial installation
87 %
DEVELOPED WATER POWER
In Terms of Turbine Installation
Jan. 1, 1930
Central Station 4,802,263 Hp.
Total Pulp and Paper 1,436,993 Hp.
Central Station 4,802,263 Hp. 84.1 %
Central Station power sold to Pulp and Paper 859,017 Hp.
Pulp and Paper 577,976 Hp. 10.1 %
Other Industries 330,563 Hp. 5.8 %
Total - 5,710,802 Hp.

more than a very short distance and the figure of $35 per horsepower given above for transmission should be at least $70 per horsepower when applied to the power which is transmitted.

The percentage of the developed power which is distributed to small power users and for domestic purposes is probably less than 20 per cent of the whole and the cost per horsepower of distributed power should therefore be $100 instead of $20 as given above.

Generation includes investment in storage and regulating dams, power houses and sites, including all equipment up to the step-up transformers.

Transmission includes investment in step-up transformer stations, transmission lines and receiving stations, but does not include the necessary step-down transformers for distribution purposes.

Distribution includes step-down transformers in receiving stations, distribution lines, substations, line transformers and meters.

General includes investments in office, buildings, stores, working capital, etc.

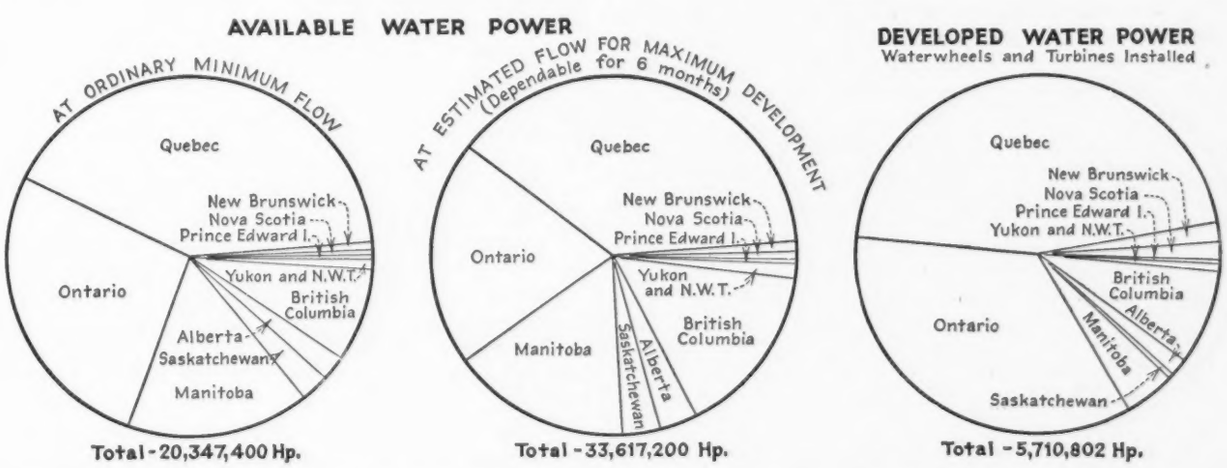
These figures, which are obtained for the industry as a whole, cannot be applied to particular properties. The figure of $152 per horsepower for power generation, including all equipment up to the generator terminals, is representative of medium capacity plants, but many plants of large capacity favorably situated have been developed below $120 per horsepower for operation at from 60 to 70 per cent load factor. Such development costs must not be exceeded if power is to be sold in large blocks at figures equivalent to $12 to $15 per horsepower at the generator busbar, as has been done in many instances during the last five years.

It must also be remembered that probably less than 50 per cent of the developed horsepower is transmitted more than a very short distance and the figure of $35 per horsepower given above for transmission should be at least $70 per horsepower when applied to the power which is transmitted.

The same government department gives for 1927 the average revenue per horsepower of primary power as $24.93 for all Canada, while in Quebec it is $19.26 and the revenue per kilowatt-hour generated as 0.72 cent for all Canada and 0.52 cent for Quebec, which has a large number of industries using large amounts of power at high load factor such as the paper mills and large chemical industries.

How far the developments of hydro-electric properties will continue and when steam-electric stations of large size will enter the field in Canada depend on a great variety of conditions, such as location of possible hydro-electric stations with respect to the load, cost of constructing the stations and the necessary transmission systems, quantity of service demanded and, finally, on the capital cost of high efficiency steam-electric stations and on the cost of coal.

The steam-electric station has already made its appearance in British Columbia, where there is an abundant supply of coal, and such stations will doubtless be constructed as stand-by and peak-load stations in some of the large hydro-electric systems, but probably not before Canada's present hydro-electric installation is doubled.



Available and developed water power in Canada based on 80 per cent efficiency and 24-hour power
(World Power Paper by J. T. Johnston)

ONE PRICE FOR POWER

SURVEY indicates an unusual degree of uniformity in power costs over the country. In very few industries is the total payment for power more than a small percentage of the total cost of operations. The cost of power is seldom a determining factor in fixing the location of an industry

By L. W. W. MORROW*

Editor ELECTRICAL WORLD

ONE aspect of electric power is the influence of its cost upon the expansion and shift of industry. In turn, this industrial development has its reflex upon the general social and economic progress of the country. This broad subject of industry growth was surveyed in a recent study† jointly undertaken by the National Electric Light Association and Metropolitan Life Insurance Company. The survey indicated that industry in the United States is developing along three major lines:

1. A growth of new industries in each market area.
2. A relocation and growth of highly specialized industries in territories that offer economic advantages for manufacturing and distribution to a national and international market.
3. The establishment of branch manufacturing plants for each market area in those industries largely devoted to mass production and mass consumption.

There are many factors involved in the decision upon the specific location of each of these new plants and the survey looked into these factors. It was found that the reasons ranked in order of importance as follows:

1. Markets.
2. Labor.
3. Transportation.
4. Materials.
5. Available factory building.
6. Personal reasons.
7. Power and fuel.
8. Cheap rent.
9. Near-related industries.
10. Living conditions.
11. Financial aid.
12. Taxes.

The position of power and fuel ranged from fifth, as elicited from the textile industry, to ninth for the leather industry. Of course this rank applies to the combined outlays for power and fuel.

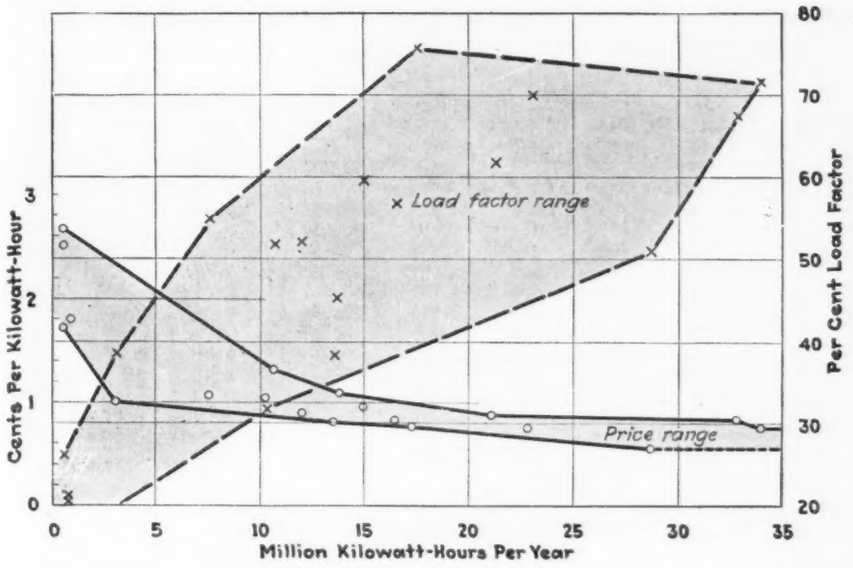
The ELECTRICAL WORLD has conducted an independent survey, obtaining from some 36 of the larger electric utilities the net charge per kilowatt-hour to 1,278 of their industrial customers for practically 3,000,000,000 kw.-hr., some 6 per cent of the total national power sales. The total demand of these plants amounted to 800,000 kw. and includes only establishments involving demands of 100 kw. and consumption in excess of 250,000 kw.-hr. Few of these utilities indicated that the establishments located in their territory because of the differential in power rates, although this has manifestly been the case in a limited number of the mass industries employing large amounts of power under good load factor conditions.

The industries reported upon may be assembled into fourteen groups and the load characteristics of these are associated with the range and average of power costs in Table I. The lowest net prices per kilowatt-hour are in general associated with the greatest consumption and the greatest demand consistent with good load factor. And, conversely, the highest rates in general accompany the smallest demands and lowest annual consumption. There are differentiating features which interfere with these complete correlations and comparisons should be drawn with caution. Thus mass industries which locate close to large sources of relatively inexpensive hydro-electric power supplies may expect lower power rates than smaller industries with lower load factor deriving power in congested industrial areas, with correspondingly heavier costs in the distribution and transmission systems. In fact, if these allowances are made adequately in each instance it is safe to make the claim that there is very little range and spread in the cost of power for any industry locating in any territory appropriate because of market, materials, labor and transportation.

Furthermore, there is correspondingly small spread of the net charges for power in any given industry in the various industrial areas of the country. Thus foundries and heavy manufacturing plants (see Table II) reflect relatively little variation in the cost of power in the different areas. And taking an industry that is practically identical in all parts of the country, the cement industry, which comprises the bulk of the business represented under the title "Cement, Brick, Glass

**Based on paper "Power Costs and Trends in the United States," World Power Conference, Berlin, 1930.*

†"Industrial Development in the United States and Canada 1926-27."

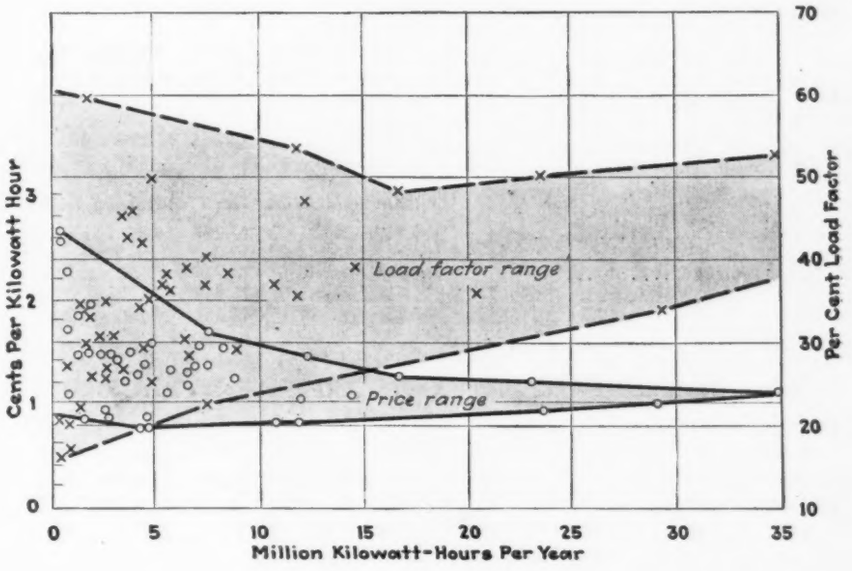


Cost of purchased power in the cement industry

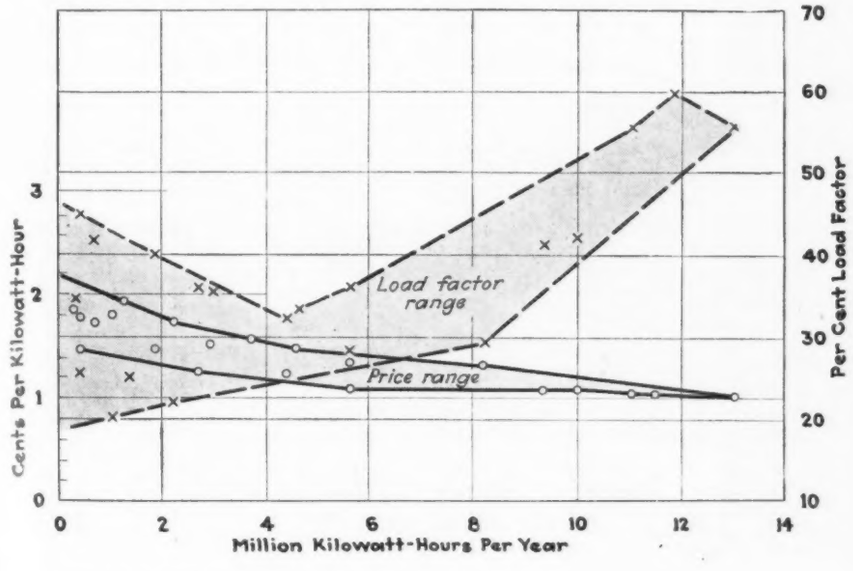
Data for seventeen widely scattered plants.

Cost of purchased power in the general manufacturing industry

Data for 50 plants all over the country show a definite correlation between the charge for power and the magnitude of the annual consumption along with the desirability of the load from the load factor standpoint. The larger plants very definitely present a better load factor and therefore earn the lower rates. The spread of load factor for the smaller plants is due to pressure production of specialties and the frequent resort to 24-hour electrical processing of products.



Cost of power in 21 textile plants



and Stone," a still greater correlation is noticeable. The minimum rate compatible with magnitude of demand and consumption lies between the limits of 0.59 and 0.83 cent. The weighted average rate is presented for what it may be worth as an index and is found to range within the narrow limits of 0.92 cent and 1.08 cents. It appears justifiable to offer to the cement industry the chance to establish wherever stone, labor, markets and transportation dictate, with the assurance that the power cost will be virtually the same in all the areas. The brick industry, partaking of seasonable character, smaller demands and consumption and power load factor, takes the major portion of the higher rates recorded.

The power companies also reported on the percentage cost of the electric power to the total cost of the industrial operation. Many of these figures were admittedly estimates because the power engineering and sales promotion departments do not have general access to the production expenses of their power customers. These estimates ranged from a fraction of 1 per cent to as high as 50 per cent for electrochemical and other special industries employing an extensive and exclusive electrical process.

Somewhat more significant data are derivable from the U. S. Census Bureau reports for certain of the industries surveyed in the 1927 Census of Manufactures. These industry reports previous to the 1927 census included fuel and power in the item "materials." The 1920 reports segre-

TABLE I—INDUSTRIAL POWER PURCHASABLE WITHIN NARROW PRICE RANGE

Industry	No. of Plants	Total Kw.-Hr. (In Millions)	Average Kw.-Hr. (In Thousands)	—Kilowatt Demand— Min.	Aver.	Max.	Total	Cents per Kw.-Hr. Min.	Aver.	Max.
Textiles	228	243	1,066	101	297	6,800	67,876	0.51	1.25	2.37
Mining and smelting	11	64	5,814	283	1,137	5,558	12,509	0.50	1.43	2.17
Foundries, heavy manufacturing	37	192	5,183	126	2,918	7,400	107,978	0.72	1.18	2.64
Automobile, airplanes	26	301	11,559	305	3,650	25,920	94,682	0.70	1.30	1.98
Cement, brick, glass, stone	19	390	4,942	175	1,033	8,130	81,650	0.59	0.99	2.91
Miscellaneous manufacturing	352	516	1,467	100	489	7,805	172,161	0.55	1.54	2.56
Food products	113	304	2,693	123	599	6,250	67,680	0.55	1.13	2.18
Printing and publishing	29	47	1,627	100	475	1,003	13,765	1.14	1.54	1.95
Paper products	37	145	3,916	149	604	2,505	22,356	0.76	1.24	1.79
Wood products	11	10	906	150	383	1,068	4,213	0.95	1.63	2.15
Chemicals	148	215	1,464	90	330	3,930	48,871	0.56	1.27	2.7
Leather products	33	22	652	100	254	2,150	8,380	1.01	1.51	2.54
Ice and refrigeration	139	189	1,358	100	334	2,534	46,426	0.83	1.13	1.41
Iron and steel	35	347	9,911	140	3,453	22,007	120,875	0.80	1.10	2.26
	1,278	2,985	2,335	90	627	25,920	801,546	0.50	1.23	2.91

TABLE II—MINOR REGIONAL DIFFERENCES IN PRICE FOR POWER

Region	No. of Plants	—Kw.-Hr. Consumed— Total	Average	Maximum Demand in Kilowatts Min.	Average	Max.	Total	Cents per Kw.-Hr. Min.	Aver.	Max.
Foundries and Heavy Manufacturing										
New England	2	4,541,500	2,270,750	160	512	965	1,025	1.48	1.59	2.25
Middle Atlantic	15	59,291,804	3,952,787	184	1,184	1,596	17,766	0.72	0.98	2.38
Middle West	13	110,141,954	8,472,458	126	6,308	7,400	82,004	1.05	1.30	2.64
South	4	5,052,263	1,263,066	205	726	1,744	2,903	1.05	1.51	2.46
Pacific	3	12,735,640	4,245,213	497	1,427	2,812	4,280	0.885	0.95	1.27
Cement, Brick, Glass and Stone Industry										
New England	4	15,981,070	3,995,268	350	1,249	4,000	5,195	0.8	1.02	2.0
Middle Atlantic	51	104,618,190	2,051,337	175	449	6,250	22,886	0.59	1.08	2.91
Middle West	12	161,096,840	13,424,737	500	2,832	8,130	33,989	0.81	0.97	2.21
South	7	31,480,800	4,497,257	177	1,041	3,252	7,285	0.83	0.96	2.08
Pacific	5	77,226,400	15,445,280	293	2,459	5,284	12,295	0.77	0.92	1.24

TABLE III—POWER COSTS ARE SMALL FRACTION OF PRODUCTION EXPENSE

Industry	Salaries	Wages	Materials and Supplies	Fuel and Power	Value Added by Manufacture	Value of Products	Fuel and Power
Automotive and aircraft	124,386,695	625,253,577	2,513,629,239	34,794,847	1,494,061,124	4,041,485,210	8.60
Beverages, flavorings	24,747,669	44,139,628	155,844,039	7,863,636	206,480,348	370,188,023	2.11
Brushes	4,909,668	12,518,720	31,135,150	593,618	34,560,268	66,289,036	0.89
Buttons	2,174,699	9,435,821	10,645,399	592,180	17,892,589	29,130,168	2.04
Canning and preserving	21,756,732	70,415,241	392,210,260	5,866,898	239,350,891	637,428,049	0.92
Cement	16,331,586	53,110,745	59,495,154	60,516,871	173,553,268	293,565,293	20.50
Clocks, watches	6,610,307	31,574,587	20,840,849	719,460	63,947,862	85,508,171	0.96
Dyestuffs	2,517,609	2,971,477	22,192,017	881,908	12,603,108	35,677,033	2.48
Electrical products	148,248,997	336,238,750	626,617,053	19,144,646	991,545,336	1,637,307,035	1.17
Embroideries	4,068,351	11,989,191	32,967,644	382,162	31,072,993	64,422,799	0.59
Fertilizers	8,936,036	17,649,661	135,368,365	2,774,560	52,241,965	190,384,890	1.45
Furniture, mattresses	67,935,726	252,996,023	430,008,965	11,562,705	536,969,194	978,540,864	1.19
Glass and glassware	13,853,782	81,352,734	79,441,368	30,470,096	172,482,866	282,394,330	10.80
Ice manufacture	14,671,505	32,611,118	11,532,532	29,282,980	143,979,476	184,794,988	15.80
Paper products	33,618,599	130,474,739	512,935,626	59,849,912	347,105,927	919,891,465	6.53
Petroleum refining	30,900,277	113,716,705	1,649,288,320	103,708,723	389,651,460	2,142,648,503	4.85
Planing mills	42,460,620	126,139,713	314,150,598	7,292,720	260,190,419	581,633,737	1.25
Railroad repair shops	85,366,132	600,516,555	486,911,931	28,158,344	690,120,435	1,205,190,710	2.35
Rubber tires	40,430,162	120,063,854	488,167,931	11,052,711	370,467,421	869,688,063	1.27
Sewing machines	3,949,679	15,879,006	16,054,929	726,574	28,440,313	45,221,816	1.61
Silk manufactures	21,920,553	140,053,588	436,192,406	9,198,270	304,733,029	750,123,705	1.22
Slaughtering, meat packing	54,641,992	161,583,827	2,640,319,602	23,420,801	393,475,315	3,057,215,718	0.76
Soap	9,766,393	19,715,931	168,065,295	4,178,835	114,815,805	287,059,935	1.45
Textile machinery	10,917,207	36,481,196	34,583,354	1,597,335	80,740,441	116,921,130	1.37
Tin cans, tinware	7,399,133	35,000,822	167,028,113	2,393,227	84,057,351	253,478,691	0.94
Wall plasterboard	4,423,677	14,411,777	26,915,238	5,083,147	51,857,623	83,856,008	6.05
Washing machines	3,756,639	10,950,046	33,971,585	556,750	40,423,003	74,951,338	0.74
Wooden boxes	6,684,242	29,250,351	74,561,159	1,236,233	58,195,485	133,992,877	0.92
Wools, worsted goods	12,059,574	72,156,158	166,321,575	6,378,658	128,608,510	301,308,743	2.12

gate "fuel and power" from "materials," but the lumping of fuel with power prevents the presentation of absolute figures as to the cost of purchased power as distinct from the expenditures for incidental and process fuel. Nevertheless, these figures are presented for several of the outstanding industries as an initial effort to disclose the relative insignificance of the cost of energy used in American industry.

It will be seen from Table III that with the exception of the automotive industry, cement making, glass production, ice manufacture, paper products and wall plaster board the cost of power and fuel is 2 per cent or less of the total value of the manufactured product. Deducting the likely cost of fuel, the cost for power in most industry can be said to fall below 2 per cent, and in many industries below 1 per cent of the cost of production. This conclusion places in question the tendency to rate power cost as of more significance in fixing the location of an industry than cheap rents or real estate, proximity to related industries, living conditions, taxes and sympathetic financial support.

Power cost a minor factor

Electric power costs are fixed by the character of the load, the magnitudes of the demand and the consumption and local power production costs, including distribution charges. To some extent the competitive aspect of production cost within the industrial plant and occasionally elements of tradition and considerations of value of service will enter into the price for power. In general, however, the charge for power may be said to rest on the pure economic grounds of cost plus return on investment; the relatively narrow spread of power charges supports the claim for economic determination of the charges.

The essential point to observe, however, is that the analysis shows that the growth of certain industry groups is governed largely by other factors than power

Five-Year Plan for Russian Electrification

Superpower stations in Russia as of 1933
(World Power paper by S. A. Koukel-Krajewsky)

Table I—Average Cost of Electric Energy in Russian Currency (Kopecks) per Kilowatt-Hour

District	1927/28 At Station Busbars	1927/28 At Consumer's End	1932/33 At Station Busbars	1932/33 At Consumer's End
Moscow	3,84	6,46	3,3	4,3
Leningrad	3,67	6,82	3,8	5,3
Ural	2,88	3,81	2,5	3,8
Donetz-Basin	5,82	7,55	1,8	2,3
Dnieper scheme	....	....	1,0	1,2
Georgian S.S.R.	....	....	3,1	3,7
Average for the U.R.S.S.	3,46	5,82	2,6	3,5

Table II—Distribution of Capacity of State Regional Stations in Exploitation and Under Construction as Estimated for September 30, 1933

District	Capacity in MW *	Capacity in MW †
I. Moscow industrial region	1028	275
II. Nishni Novgorod district	209,5	270
III. Ivanovo industrial district	454	100
IV. Leningrad district	625,5	280
V. Ural district	407	360
VI. Central Black Earth district	72	48
VII. North Caucasus district	373,5	299
VIII. Middle Volga district	107	65
IX. Low Volga district	136	124
X. Western district	57	24
XI. Siberia	192	224
XII. Caucasus Auton. S.S.R.	88	70
Total for R.S.F.S.R.	3738,5	2139
Out of this number hydro stations	239,5	385
XIII. Ukrainian S.S.R.	1056	490
XIV. Transcaucasian S.F.S.R.	360,5	79
XV. White-Russian S.S.R.	64	43
XVI. Uzbekian S.S.R.	70	90
Total for the U.S.S.R.	5300	2846
Out of which number hydro stations	891	732

*Under exploitation.
†Under construction less stations whose construction is to begin in Summer 1933.

costs. Notable exceptions are found in the development of electrochemical industries near Niagara and in West Virginia and the location of aluminum and other metallurgical production plants at locations where cheap power was available. This move was dictated by the relatively large amount of power consumption and the low rate was earned by the advantageous character of the load from the power company's standpoint. The growth of the brass industry in Connecticut, of the automobile industry in Michigan and of the textile industry in New England and in the South were governed largely by factors other than power costs.

A few years ago there was a decided differential in the cost of power in the several market areas of this country, but this has been eliminated very largely by economies in production and interchange of power. In fact, the determining factor in industrial location should be viewed as the universal availability of reliable electric power at economic rates. This availability and uniformity of charge has contributed materially to the expansion and diffusion of average industry more than any outstanding attractiveness of differentials in power prices. Markets, labor, raw materials and transportation will govern future industrial growth to a far greater extent than any matter of availability or cost of electric power.

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Electric Rate Analyses

Promotional rates increasing in favor. Analysis of discrimination claims on rates for different classes of business. Cost analysis for rate base

By L. R. NASH*

Stone & Webster Service Corporation, Boston, Mass.

THERE is a definite and pronounced trend throughout the United States toward rates of promotional form designed to stimulate a steadily increasing volume of business and permitting lower average unit costs. This trend has sound economic foundation and should be of advantage alike to producers and users. Some of the rate reductions made in recent years would have been impracticable but for certain developments which have had a marked effect upon costs.

The principle on which promotional rates are based is that there should be an assured recovery from all customers of those cost elements which are independent of the actual taking of energy. With these costs provided for, the charge for the energy itself may be quite low, thereby stimulating the volume of business which the companies are seeking.

All the promotional forms of rates have their advantages and disadvantages. As between rooms and area as the basis of a service charge or the size of the initial energy block, there is still much difference of opinion. Where homes are reasonably uniform in character and accurate real estate records of defined rooms are available, this basis has advantages. In the absence of such real estate records and with wide variations in the character of homes and sizes of rooms, the area method is simpler. It is the usual practice to determine such area by outside measurements without disturbance of occupants, with deductions for partitions, closets, and other unlighted space. It is usual with both room and area charges to establish a minimum and to provide suitable reductions for large and ordinarily unoccupied space.

There is also much difference of opinion as to the use of distinct service charges as compared with other forms of rates in which such charges are not separated. There is general agreement that the direct service charge is logical and preferable because the maximum stated rate for energy may be relatively low and attractive. Much objection, however, still exists on the part of customers to an adequate service charge. In deference

*Based on paper "Electric Tariffs in the United States and the Proper Relation Between Industrial, Commercial and Domestic Rates," World Power Conference, Berlin, 1930.

to such objections, the indirect service charge as embodied in the Wright form of rate or the initial charge rate, is still being used and introduced in considerable numbers. The progress being made with direct service charge is, however, encouraging, and their more extended use may be expected when customers become more fully informed as to their advantages. A definite objective in all these forms of rates is that complete residence service is recorded through one meter.

Relative profitableness of classes of business

Criticism has frequently been made that domestic rates are too high and wholesale power rates are too low. It is, therefore, assumed that small and helpless domestic consumers are helping to pay the bills for industrial service.

It has been shown that some, at least, of these criticisms are based on inaccurate data or premises that cannot be sustained. A survey of the electric power industry in the United States for the year 1928 shows for average customers the consumption and rates applicable thereto for different classes of service as given in the following table:

	Kw.-Hr. per Month	Rate per Kw.-Hr., Cents
Industrial	6,400	1.44
Commercial	275	4.55
Residential	38	6.55

Industrial service as above defined, including wholesale power and power sold for railroad electrification, amounted to approximately two-thirds of the entire kilowatt-hour sales of the industry to ultimate consumers. Commercial service, including lighting and small power, required about one-sixth of the total kilowatt-hour sales. Residence service, including domestic use and some farm service, amounted to about one-eighth of the total. The extreme spread between high and low rates in specific cases is, of course, greater than that shown in the table. Domestic rates in remote localities are in some cases more than double the average shown above. On the other hand, some of the largest wholesale power contracts for which data are available involve cost per kilowatt-hour not much greater than 50 per cent of the above industrial average rate.

Difficulties of cost allocation

It is impossible without analysis to tell whether a power rate for service 170 times the average volume of residence service should properly have a rate only 23 per cent of the residence average, or whether commercial service of 23 times the volume of residence service should have a rate only 70 per cent of the residence rate. Such analyses have been undertaken in only a limited number of cases because of the difficulty encountered, particularly in the allocation of jointly used facilities. Service of all classes is furnished from the same power plants and distributed, in part at least, over the same lines.

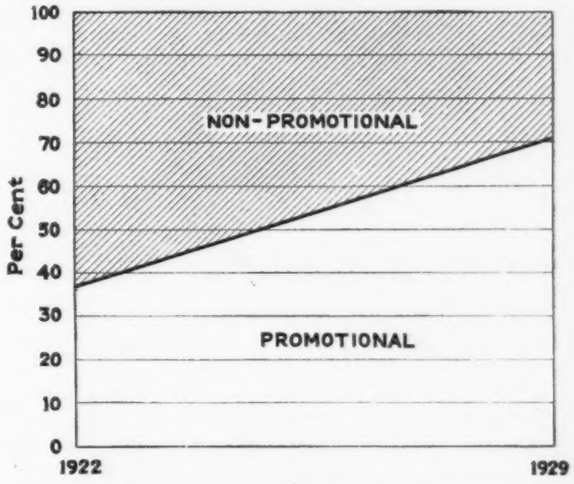
In spite of the difficulties of allocation, relating not only to investment but also operating expenses, a number of companies have made estimates embodying the best judgment of their skilled engineers, accountants, and executives. In general, *the results indicate that the maximum return upon allocated investment is derived from commercial lighting and small power, the return from both wholesale power and residence service being relatively low.* If such analyses are approximately correct, or even if they embody material errors, they refute the contention that domestic service is unduly profitable or that it helps to support wholesale power business.

Cost analysis

It has been stated herein that estimates of cost of different classes of service could not be made with very satisfactory accuracy because of the wide possible latitude in allocation of investment in joint facilities and of operating expenses. It should not be inferred from such statement that all cost analyses involve similar inaccuracy. Many detailed analyses of cost have been made along different lines from that above referred to, which from their character permit a greater degree of refinement, and their results have been both illuminating and helpful. The usual basis of such analyses is a division of costs of all kinds into three major groups:

1. Costs per unit of demand.
2. Customer costs.
3. Costs per kilowatt-hour sold.

While there is naturally wide variation in the unit costs per kilowatt, per customer and per kilowatt-hour, for properties having widely different locations and operating conditions, the range of such costs for reasonably normal conditions may be indicated. Customer costs show least variation and are found to be not far from $1 per month. Demand costs for obvious reasons are quite variable, fluctuating widely from a mean not far from $4 per kilowatt of mean station demand. The energy component in the cost also varies widely, but when adequate allowance is made for items outside the production group, the total is usually not far from one cent per kilowatt-hour, but may be 50 per cent or more above that amount for small systems.



Trend of residence rates in the U. S. toward promotional type

Cities over 20,000

For residence service the percentage has increased from 36 to 71 since 1922. The percentage of cities having promotional rates for both residential and commercial service has increased from 41 to 69.

BETTER Load Factor

What it means to energy production costs. Methods for improving load factor. Data and statistics on new types of load

By GEORGE H. JONES*

Power Engineer Commonwealth Edison Company

A STUDY of 115 of the large utilities in the United States shows that 82 per cent of them had peaks occurring in the late fall, 54 per cent in December and 35 per cent in the week immediately preceding Christmas. The load factor depends on the habits, industry and commercial activities of the utility in any territory.

Despite great improvements in the load factor in the past few years, it is apparent that 75 per cent load factor is yet to be attained generally, and this is the value that makes for more economical operation. A study of possible loads and interconnections, with complete development of business, indicates a possible industry load factor of 76.8 per cent. This is the industry goal.

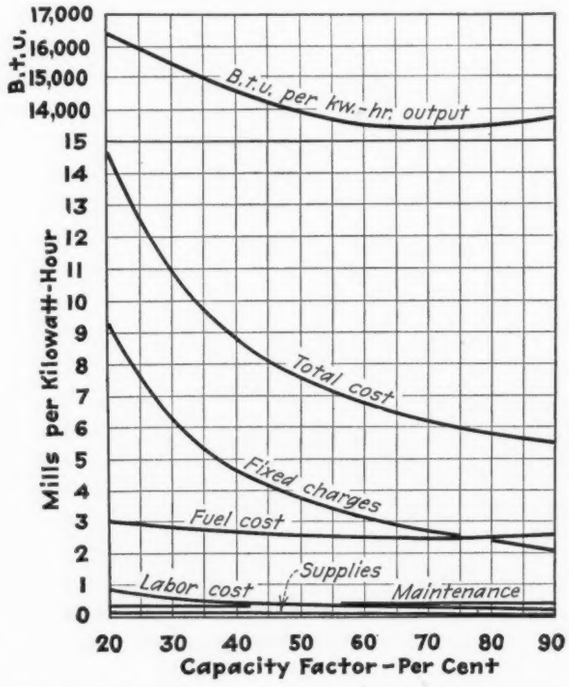
Domestic load offers greatest possibilities

Load factor improvement can be brought about by

1. Increasing the hours' use of present customers.
2. Increasing the diversity of use of present customers by means of specially developed rate schedules.
3. Adding new uses having considerable diversity with the present load.

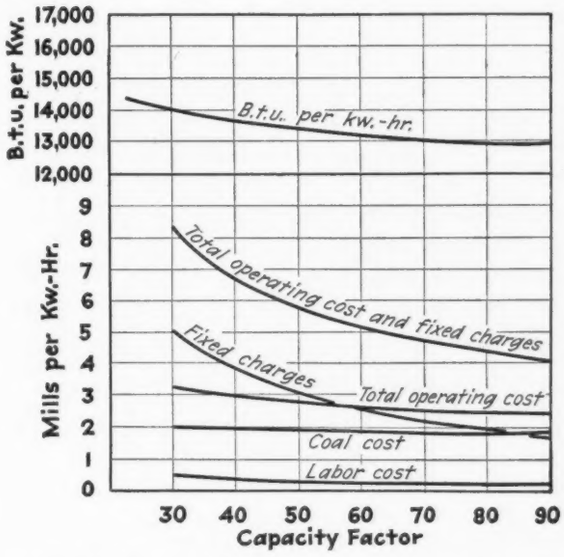
In general, it is better to build a high load factor by developing a great variety of uses for electric service as compared to the attainment of high diversity in a few large customers.

It is believed that the domestic load offers the greatest possibilities for increasing revenue and load factor with the smallest increase in investment per unit of added load. Of all the appliances the oil burner and refrigerator give the greatest load to utilities, each contributing more than 400 kw.-hr. to the customer's load. There are 1,200,000 refrigerators in use, using 500,000,000 kw.-hr. per year. The sale of 500,000 machines annually would contribute 200,000,000 kw.-hr. per year to the domestic load at high load factor. There are 500,000 oil burners



Effect of capacity factor on generating costs of a large steam plant using pulverized fuel

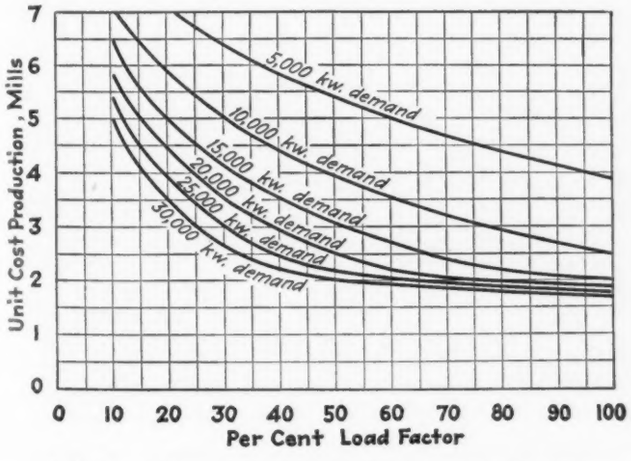
*Based on paper "Effect of Load Factor on the Cost of Production and Methods of Improving Load Factor," World Power Conference, Berlin, 1930.



Estimated costs for power at various capacity factors for Powerton steam plant

Appliances Used in 5,000 Homes in Chicago

Appliance	Annual Kw.-Hr.	Per Cent Saturation	Per Cent in Regular Use
Washer	25	35	93
Vacuum cleaner	30	87	98
Ironer	100	6	98
Refrigerator	800	10	99
Flat-iron	72	96	99
Toaster	37	36	86
Percolator	42	16	62
Sewing machine	17	11	88
Radio	20	54	99.5
Fan	16	13	81
Heater	42	10	70
Kitchen ventilator	50	1	97
Table stove	37	2	43
Waffle iron	30	8	74
Heating pad	16	6	80
Curling iron	25	4	51
Hair drier	25	1	73
Vibrator	10	1	73
Charger	20	4	90
Ultra-violet lamp	30	1	64
Fireplace	40	1	71
Clock	50	1	96

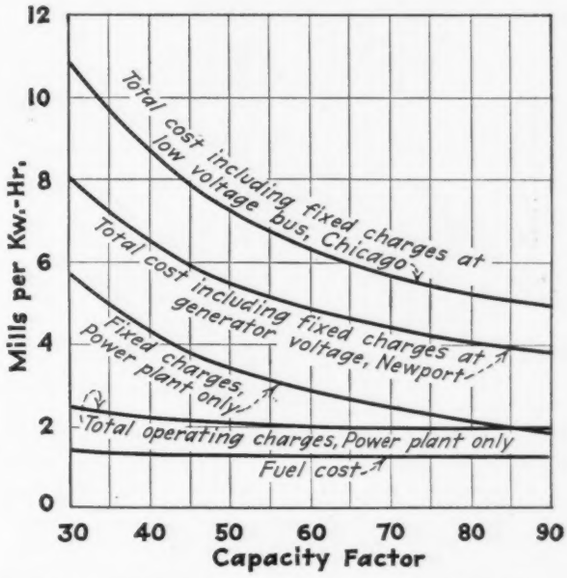


Relation of generating station operating costs to load factor, 30,000-kw. station

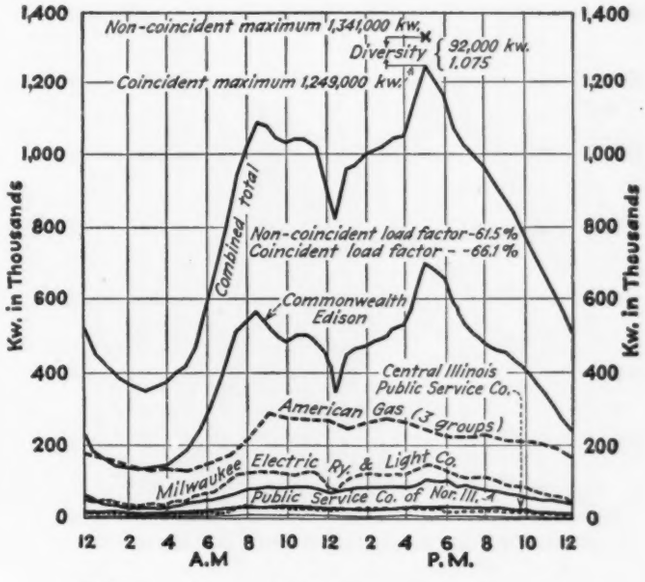
now in use, with a load factor of 17 to 25 per cent on an annual basis, each contributing about 456 kw.-hr. per year to the load.

Electric hot water heating is another unexploited business that should add about 360 kw.-hr. per month for every 40 gal. use per day, at a load factor of 75 per cent. Another possibility is electric house heating, with an annual use of 30,000 to 60,000 kw.-hr. at high load factor. This load has been developed greatly abroad, one town in Switzerland having improved its load factor from 29 in 1910 to 70 in 1928.

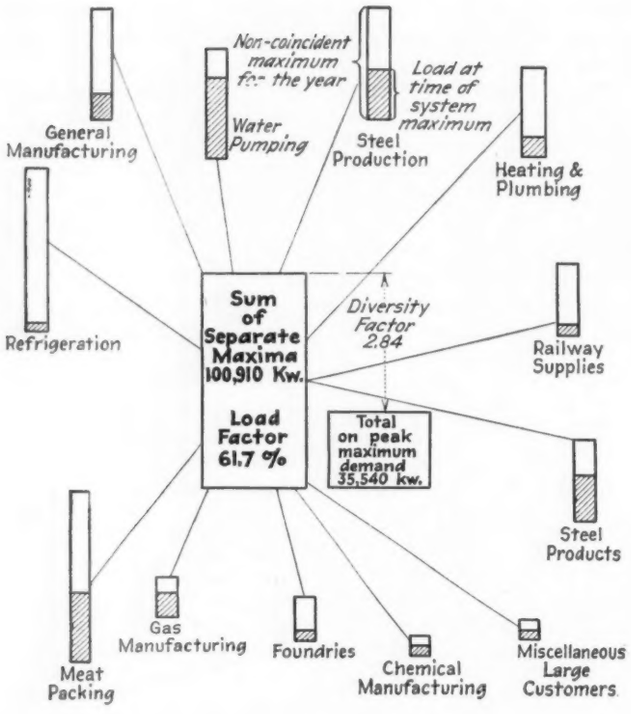
The time elements involved in daylight saving can be used to improve utility load conditions and suggest pos-


Mills per Kw.-Hr.
Total cost including fixed charges at low voltage bus, Chicago
Total cost including fixed charges at generator voltage, Newport
Fixed charges, Power plant only
Total operating charges, Power plant only
Fuel cost
Capacity Factor

Effect of capacity factor on 200,000-kw., 1,200-lb. pressure station using unit mill pulverizers



Effect of a typical interconnection on load factors



Load factor study for groups of large industrial customers of Commonwealth Edison Company

sibilities for staggering certain classes of work in a community to the advantage of transportation facilities and for the improvement of load factor.

In the industrial field the possibilities for air-conditioning applications are large, but only on long-hour processes will this secure an improved load factor. Certain classes of business, such as cotton mills, theaters and foundries, can be studied for business and load factor improvement to good advantage, especially if electric heating is also brought into conjunction with air-conditioning possibilities.

In agriculture and rural service the annual load factor at present is only about 4 per cent. The addition of irrigation, pumping and drainage can be used to improve the load factor appreciably. Added use, more appliances and complete service are needed, both to make rural business profitable and to add to its load factor.

Interconnection gives opportunity for load factor improvement. In a typical interconnection in Indiana, Illinois and Wisconsin interconnection gives a diversity of 92,000 kw. and a load factor improvement of 8 per cent. More illumination, electric trucks, electric heat and many other loads afford opportunity for load factor improvement.

World Power Conference headquarters

The Adlon Hotel Berlin

More Lines, Fewer Stations

Reliability statistics of transmission service questioned. Advocates Baum principle of transmission. New knowledge makes transmission economical and reliable

By C. L. FORTESCUE*

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FOR the same length of line the same amount of power can be transmitted with a higher efficiency with a given order of stability as the transmission voltage is increased, and the amount of copper required for the same amount of power will be inversely proportional to the voltage and the transmission loss per mile will also be inversely proportional to the voltage.

It is pertinent to ask, then, why the gain in cost by high-voltage transmission is not greater. The answer is that while the cost of conductors is reduced for a given amount of power transmitted, the cost of the line supports increases at a rate probably not far from being proportional to the square of the voltage. This is due to the fact that the wind stresses, distortional stresses and sleet load are increased in proportion to the voltage and the towers have to be made considerably higher as the voltage is increased. There is, therefore, a gain due to the decrease in conductor cost per kilowatt transmitted, but this gain is not a large percentage of the total cost of the transmission line and may be entirely wiped out if the conditions for the lower voltage are more favorable to stability. To illustrate by an example, let us suppose that it is desired to transmit a certain amount of power to 154 kv. or 220 kv. and it is found that with four lines at 154 kv. the conditions for stability are just satisfied. What will be the conditions at 220 kv.? Here the number of lines should be two, but we find that with two lines the system will not be stable. It will therefore be necessary to use three lines, and these lines, even with the same amount of copper, will cost more than the four 154-kv. lines.

Transmission lines should be compared on the basis of equal distances and amount of power proportional to the square of the voltage, or, what is the same thing, on the basis of the same number of lines. On this basis the cost of transmission per mile per kilowatt transmitted is reduced with increase in transmission voltage. As regards synchronous condenser capacity required, this is proportional to the square of the transmission voltage and will, therefore, for a given length of line, whatever the voltage, be proportional to the amount of power transmitted for the given stability conditions imposed.

The cost per mile of single-circuit transmission lines, constructed according to the specifications outlined in the previous discussion, may be approximately obtained by the following formula:

$$\text{Cost per mile of line in dollars} = 3{,}200\left(\frac{\text{kv.}}{100}\right) + 3{,}200\left(\frac{\text{kv.}}{100}\right)^2 + 230\left(\frac{\text{kv.}}{100}\right)^3$$

According to this formula a 220-kv. line would cost $25,000 per mile, a 155-kv. line would cost $13,500 per mile. The former would, for the same conditions of stability, transmit twice the amount of power that the latter would and the cost per kilowatt per mile for the latter is only 8 per cent greater than the former.

Effect of quick-response excitation

It is customary in stability calculations to assume that the flux linkages of the field remain constant during the fault condition and after the fault is cleared the building up of voltage will depend on the type of excitation used. Quick-response excitation insures that the field flux linkages shall not decrease; the rate at which the flux may be increased depends upon the maximum exciter voltage obtainable. In the above discussion no mention is made of the reactance of the generator and transformer which enters into the stability problem, but it may be well to state that on a proper basis of comparison the rating for the generator and transformers should be proportional to the static stability limit of

**Based on paper "The Economics of Power Transmission as Influenced by Recent Stability Studies and Increase in Speed of Circuit Interruption," World Power Conference, Berlin, 1930.*

the line for different lengths under consideration, and therefore the reactance of generators will always be proportional to the reactance of the line. Consequently the phase angle for a given condition of stability will be practically constant whatever the length of line.

Effect of high-speed interruption of faults

Within the last year great advances have been made in the design of circuit interrupters. As a result of recent developments it is practicable to use a circuit breaker which will clear a fault in eight cycles or less after its initiation. Even with a double-line fault to ground the clearing of the fault by an eight-cycle breaker reduces the system disturbance to little more than that which would result from switching out one line under load. With the most severe type of fault for the same stability the load limit has been raised from 0.25 to 0.76. For a more frequent type of fault the increase is from 0.62 to 0.86, a very substantial gain, and for line-to-ground faults, which are the most frequent of all, there is a substantial gain from 0.71 to 0.895. When long-distance transmission has to be considered, we at once see that merely raising the transmission voltage does not permit of increasing the distance that power can be transmitted in the same proportion. It is true that some economy may be obtained for long-distance transmission by using hollow conductors or conductors with steel cores, but in countries where sleet is predominant and where wind velocities are high the resulting saving is not very great. It appears to the writer that a rational policy should aim to use as large conductors as possible and load them so that the cost of the losses and the corresponding cost of the line are compatible. It does not seem sound from an economic point of view to reduce the carrying capacity of the conductors for the sake of using a straightaway transmission line.

Kva. requirement of transmission discussed

A feature of transmission lines which does not seem to be generally understood is that, just as much as in the case of a dynamo-electric machine, they require excitation. This excitation, as in the case of a dynamo-electric machine, will vary with the load, and must be supplied either by the generators or by synchronous condensers or by both.

Exciting kva. may be transmitted just the same as power, and if one elects to transmit wattless kva. it will be done at the expense of power transmission. This is just as true for a transmission line as for a generator. In the latter we say it is operating at low power factor and rate it accordingly. The excitation requirements for a transmission line are distributed over the line and will vary with the amount of power transmitted.

One way in which the excitation requirements of a long transmission line may be met is by inserting in series with the line static condensers or other forms of negative reactance. This method was suggested by the writer prior to 1915, but was not advocated by him on account of several serious objections. One of the objections is that condensers have a limiting voltage, and if they are subjected to higher voltage for an appreciable length of time they are liable to breakdown, consequently the condensers installed must be rated on the basis of the maximum sustained overvoltage and they must be protected against any abnormal voltage they might be subjected to during faults, by protective gaps, saturation of magnetic circuits of step-down transformers or equivalent devices. It should be stated that when there are several transmission lines in multiple the increased rating of the condensers may not be very great and the effect of the protective devices during fault condition is probably beneficial. Another objection is that each installation requires a rather complicated insulating structure, which may give trouble during lightning storms. This method of compensating for the effect of the line reactance might be called the series excitation method.

Discussion of Baum principle of power transmission

In 1921 Frank G. Baum, in a paper presented at the summer convention of the A.I.E.E. at Salt Lake City, proposed a method for transmitting power over long lines which consisted in placing at suitable intervals along the line synchronous condenser stations or other suitable wattless kva. generating means of sufficient rating and so regulated that under all conditions of operation the voltage at these points would be maintained within a predetermined range of variation. Baum called this type of transmission line a constant potential line.

The recent development in circuit breakers enables the transmission engineer to use the Baum system to its fullest economy. The ability to transmit power with stability over distances using the Baum system is approximately the same as that of one of its sections, except for the line losses which must be subtracted.

It is well known that for short transmission lines—that is to say, lines below 100 miles in length—the economics of the line may be computed, taking stability into consideration on the basis of a modification of Kelvin's law. With long lines of the order of 200 or 300 miles the design of the line is dictated almost entirely by the limitations imposed by considerations of stability. This means that the power limit with stability of long straightaway lines is very small and, since the controlling factors in mechanical design of most lines are sleet and wind conditions, very little gain in cost of lines can be effected by reduction in weight of conductor, due to the lowered power transmission. Consequently, the cost per mile per kilowatt transmitted increases rapidly with the length of the line with straightaway transmission. In the case of the Baum system, the requirements in the matter of excitation of the line are practically proportional to the length of the line, and the amount of power transmitted is independent of the length of line, except for line losses, and, therefore, the cost per mile per kilowatt transmitted for the full length of line, as compared to one section, is practically in inverse proportion to their electrical efficiencies.

The importance of the Baum system in the economics of long-distance power transmission cannot be overestimated. On account of lack of reliable data on the cost of 220-kv. transmission lines and the influence of such factors as weight of conductor and the total cost per mile of line, it is not possible at the present time to give actual figures for the cost per mile per kilowatt transmitted for straightaway lines and lines utilizing the Baum principle, but I think that it is conservative to say that for a 300-mile line there will be a saving in cost with the Baum system of between 10 per cent and 20 per cent over the straightaway system, and for

lines 400 or 500 miles in length the saving increases very rapidly.

The long-distance transmission of base power has been criticised in America on the score of the unreliability of transmission lines as shown by statistics gathered in recent years on existing lines and the building of small (100,000-kw.) steam-driven power plants at strategic points in long power supply systems has been advocated. Conclusions based on statistics are frequently erroneous and, in this case, the incorrectness of the conclusions is almost too obvious to need refutation. In the past a large proportion of transmission lines were designed and operated without any consideration being given to conditions of stability. While the greater part of the outages have been caused in the past by lightning, a large number have been due to causes which can be remedied, such as false relay operation and mistakes in operation. As regards the outages due to lightning, these may be reduced to one-half or one-third by the addition of overhead ground wires to a large number of lines which are operating at the present time without this protection. As regards future high-voltage, long-distance transmission lines, these will probably be 220 kv.

As regards the suggestion that small (100,000-kw.) steam plants having high steam economy should be distributed through a large system, this seems to me to be economically retrogressive, since it entails handling and rehandling of coal in relatively small amounts, which is always a costly process. It seems to me that the economic trend is in the opposite direction; that is to say, toward the concentration of high efficiency generating stations at points where coal can be obtained with a minimum amount of handling and transportation charges, and to the transmission of the power from these plants by transmission lines designed and built economically, so that the cost of transmission of the energy delivered by them will be less than the cost of transporting and handling the amount of coal required to generate the same energy at the points of distribution.

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Hydro-Steam Combinations

Economic study shows many advantages to generation by use of both steam and hydro plants. Typical example of Conowingo interconnection

By N. E. FUNK*

Vice-President Philadelphia Electric Company

A HYDRO-ELECTRIC system serving very important load centers should have relay generating stations at these load centers that can immediately supply the most important part of the load in the event of transmission line failures. This entails added investment for duplication of capacity which is absent in properly proportioned combined systems, since the steam plants are always available to carry the important loads.

Usually the operating and investment cost of a hydro system is more adversely affected by a low system load factor than is the case of a combined system with its lower investment per unit of power supplied.

With limited stream flow, a material increase in the load factor of a given system with growth may entail the development of additional hydro to supply the added energy without adding a corresponding firm capacity to the system due to the decrease in firm capacity of the existing plants caused by increased hours of operation for the same stream flow made necesary by increase system load factor. This factor is not present in a combined system because there is no fundamental limitation to the load factor of a steam system comparable to stream-flow limitations.

The increase in size of steam units has brought with it increased time requirements for starting up units. This makes it necessary to operate excess steam capacity to insure service. The hydro plant is an ideal supplement to these large steam units because the starting time of the hydro units is relatively short.

The operation of peak-load steam plants is expensive, but a hydro plant may be used as a peak-load carrier at comparatively low operating costs during low stream-flow periods and yet give low operating costs for base

Based on paper "Economics of Combined Hydro and Steam Power Systems," World Power Conference, Berlin, 1930.

loads during high stream-flow periods. This advantage can be used only on large combined steam-hydro systems.

Stream-flow conditions govern operation on combined systems very largely. The most difficult operating condition is encountered where stream-flow plants are used with little or no storage. Under these conditions the hydro plant must operate at either base-load or peak-load at different intervals and the entire system must be large to permit of this transfer in operating conditions. The firm capacity of the hydro station can be preserved by peak operation only if the load is of a size that the energy under the peak of the load equal to the hydro capacity is equal to or less than the energy generated from the equalized minimum stream-flow.

Typical operations of the Conowingo plant in conjunction with the interconnected steam and hydro stations are given in Table I as illustrating the variables to be expected on a stream-flow station.

Table I—Stream-Flow Hydro Plant on a Large Combined System

System Load Factor, Per Cent		
Firm capacity in per cent of average load	30	60
As limited by December low flow	90	28
As limited by July low flow	118	27
Energy in Per Cent of Total System Energy		
100 per cent stream flow, December	66.5	28
50 per cent stream flow, December	50	28
5 per cent stream flow, December	5	5
50 per cent stream flow, July	50	28
10 per cent stream flow, July	10	10

It is seen that the summer low flow has not limited the capacity as much as the winter low flow for the 30 per cent load factor system and only slightly more for the 60 per cent load factor system because the summer low flow was assumed to be twice the value of the winter low flow.

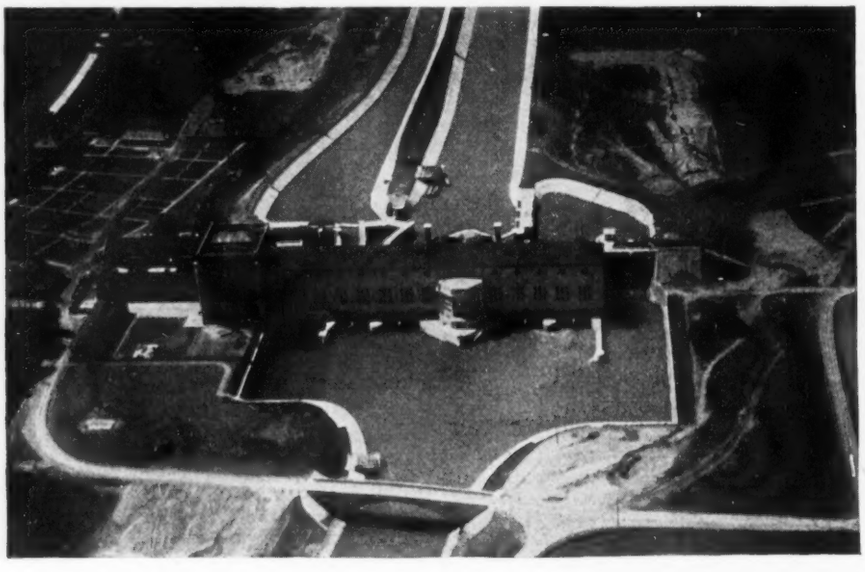
In order to illustrate the method of approach for an economic analysis a certain load is used as a base to be supplied by an all-steam system or by a combined hydro-steam system. The steam plant cost is assumed as $115 per kilowatt, the hydro plant as $260 per kilowatt. Carrying charges are 9 per cent on the hydro and 12 per cent on the steam. Operating costs of the steam plant are assumed as $4 per kilowatt-year on peak plus 2.5 mills per kilowatt-hour and the hydro operating cost as $1.50 per kilowatt-year. In Table II the result of such assumptions when calculated and applied to a given load are shown.

Table II—Comparison of Energy Costs on Steam and Combination Systems

	System Load Factor—30 Per Cent		System Load Factor—60 Per Cent	
	All Steam	Combined	All Steam	Combined
Number of Steam Plants	2	2	1	1
Number of Hydro Plants	0	1	0	1
Annual Carrying Charges				
Steam	$38.77	$31.21	$19.34	$16.99
Hydro	.....	$15.30	.....	$9.72
Operating Demand Cost				
Steam	$11.42	$7.82	$5.70	$4.60
Hydro	.....	$1.35	.....	$10.41
Energy Cost				
Steam	$20.15	$14.53	$20.15	$16.77
Hydro	.....	.....	.....	.....
Total Cost	$70.34	$70.21	$45.19	$48.49
Cost per kilowatt-hour, cents	0.873	0.871	0.561	0.602

It is seen that the hydro is not of interest at a system load factor of 60 per cent and is of doubtful value at 30 per cent load factor. Whether to develop the hydro depends upon the system growth and load factor conditions. In the all-steam system cited a new steam plant will be required shortly because of load growth, but would not be required on the combined system until the load had more than doubled. This factor and the relative costs involved make hydro development very profitable for 30 per cent load factor conditions. The results show that any variable stream must be developed up to but not beyond the maximum firm capacity that can be obtained by running the hydro plant as a peak-load station during the low-flow season.

The illustrations used in the economic analysis indicate a method for evaluating the many factors that enter into an economic analysis of all steam versus combined hydro and steam systems. It is seen that many variables enter into each case and that generalizations are dangerous. There is no doubt, however, that adequate analysis will prove that many combination systems are more economical than either an all-steam or an all-hydro system.



Finsing power station in Germany

Utility and Industrial Interconnections

By GEORGE E. WHITWELL*

Vice-President Duquesne Light Company, Pittsburgh, Pa.

Illustrative example of application of economics and principles. General rules for utility and industrial agreements. Economies for both parties

IN ORDER to give a concrete example of the type of questions that arise and of the method of making an interconnection agreement between a utility and industrial plant, we will consider an actual case of a large steel company. The utility prepared a 60-page typewritten report outlining in detail the problem both from the industrial plant's viewpoint and that of the utility. A few of the highlights are of interest:

1. The report concludes with the statement that the representatives of both parties consider it feasible and mutually profitable to make an interconnection of 15,000 kw.

2. A $300,000 frequency changer from 25 to 60 cycles and vice versa, so that power may be interchanged in either direction, is a necessary part of the equipment to make possible the interconnection. An extension of transmission system by the utility costing $125,000 is also necessary. The annual fixed charges, figuring 13 per cent, will be $55,250 on the $425,000 capital expenditure involved.

3. There is available in the transmission system of the power company in the district under consideration capacity of 15,000 kw. at unity power factor.

4. The steel company has available spare generating capacity to act as standby to the utility's transmission system.

5. The utility increases its generating capacity in blocks large enough to take care of two or three years of system growth; hence, immediately after an increase in generating capacity, there can be available for a period of from one to three years considerable surplus energy which may be used by the steel company or others up to the time that it is absorbed by the normal growth of the utility's load. During such limited periods of time the utility can sell firm power to the steel company without additional investment in generating facilities, thus permitting the steel company to delay investment in its own power plant extensions.

6. The utility's total cost of increment energy delivered at the steel plant, and properly safeguarded in the event of changes in the price of coal, is such that, for limited periods of one to three years, it is mutually profitable for the steel company to purchase surplus energy up to the limit of the interconnection.

7. Three general classes of service are recognized:

Emergency Energy.—Covering unforeseen requirements by either company to be supplied by the other when it has facilities available.

Dump Energy.—Which will be bought from the steel company by the utility when the former has a surplus which it wishes to dispose of.

Surplus Energy.—Which may be supplied by either company to the other for considerable periods under a mutual agreement made previously to the starting of such supply

8. Thirty million kilowatt-hours per year bought by the utility as dump energy during week-end and night periods covers the cost to the industrial of interconnection fixed charges. The 30,000,000 kw.-hr. per year represents approximately 50 per cent load factor. The price to the utility is such that no loss is suffered by it, and a profit sufficient to meet fixed charge on necessary equipment accrues to the industrial. Thus from otherwise waste heat in the industrial's plant sufficient dump energy

*Based on paper "Commercial Aspects of Interchanging Power Between Utilities and Large Industrials," World Power Conference, Berlin, 1930.

can be made and sold to warrant necessary capital expenditure for frequency changer and new transmission facilities.

9. With fixed charges on capital expenditures provided for, the interconnection is made and surplus or emergency energy can be profitably exchanged.

General aspects of interconnection

Having reviewed a method of solving the problems connected with this steel plant, let us set down some general rules that will be helpful in solving similar problems.

Situations in Which New Types of Relations Are Most Often Called For:

(a) Large demand for process steam at pressure consistent with power production before steam is used for process purposes—surplus of process steam requirements or at least enough for power use—coincidence of power and process services.

(b) Demand for process steam less than amount required for making needed power with adequate condensing water and good load factor.

(c) Steam for process at high enough pressure for power generation.

(d) Large supply of waste heat at high enough temperature for economic steam generation.

(e) Large supply of combustible material as by-product of process work, such as wood waste or combustible gas.

(f) Very large power requirements at good load factor in location where fuel and condensing water are available at competitive prices, so large and economical power plant can be constructed.

(g) Ownership of water power site near industrial plant.

Financial and Legal Phases:

I. Amortization of Investment:

(a) Utility must be able to justify expenditure on basis of both future as well as present conditions.

(b) Care must be taken to see that conditions do not change over a period of years. For instance, industrial may go out of business, its financial status and executive personnel may be materially altered and thus seriously affect utility's investment.

(c) Several ways of protecting the investment in special plant or equipment are enumerated below:

1. Sell plant outright to the industrial.
2. Sell plant to the industrial on the installment plan.
3. Plant leased to the industrial but operated by the utility.
4. Plant built by the industrial and operated by the utility.
5. Special equipment installed by the utility in the industrial's plant.
6. Joint ownership of plant or equipment.

II. Factors Affecting Rates:

(a) Power or other service sold to the industrial.

(b) Power or other service sold by the industrial to the utility.

(c) Sale of steam to the industrial by the utility.

Interconnection economies merit thought

Interconnection relationships between utilities and industrials should be based upon sound economic advantage to both parties. Changing conditions have made such interconnections both necessary and profitable. It is thought that this new relationship between utilities and industrials warrants the best thought that can be given it by utility commercial executives.

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Sloan Answers Sackett Statement

Matthew S. Sloan, president of the National Electric Light Association, in a statement issued June 18 from the San Francisco convention of the association, challenged the accuracy of statements reported to have been made by Ambassador Sackett in a speech to the World Power Conference at Berlin.

"Ambassador Sackett is mistaken in his facts. Electricity does not cost the great mass of consumers fifteen times what it costs to produce, as he said. On the average the country over the sales price to domestic consumers is not over four times the cost of energy at the power house.

"The Ambassador discloses a lack of understanding of the fundamental economics of business generally, and particularly of electric service.

"Business men know that cost of goods at the factory is a small part of the price paid by customers. Costs of advertising, transporting, distributing, selling, marketing, and servicing, taken together, are the largest element of sales price in most cases.

"Electric service is no exception. The cost of electric power at the power house is the smallest item. The large items of expense in serving our domestic consumers are costs of lines, facilities to deliver the electricity to their homes, losses in delivery, reading the meters, billing, collecting, and maintaining the service ready for instant use. These costs are incurred in large part regardless of how much electricity our household consumer uses.

"We do not sell a commodity. We sell a service. Our customers cannot go to the power house and get their electricity, pay us cash, and carry it home. We cannot store electricity and await future sales. Electric service must be constantly ready for immediate use in any quantity our customers demand. These conditions govern the sales price. It is a matter of pride with us that the average of prices to the great mass of consumers has steadily been reduced year by year."

Economics of Railway Electrification

Direct and indirect savings indicate rapid growth of electrification. Economic principles outlined for divisional electrification. Direct and indirect savings must be computed

By GEORGE GIBBS*

Consulting Engineer, New York

ABOUT 40 per cent, or 250,000 miles, of the railway electrification in the world is found in the United States. The per capita use of railway service is from seven to fifteen times as great as in the most highly developed countries of Europe.

Despite the growth of railroads and the reduction in costs, the time is approaching when further cheapening of unit costs will be difficult without the adoption of some radical operating changes. These, apparently, are not to be obtained economically from steam locomotive haulage. The railroads are looking hopefully to electrification for help.

Deficiencies in steam locomotive haulage are well known and several forms of haulage have been developed to advantage. Assuming that the gas-electric locomotive becomes perfected, its total operating cost, exclusive of fixed charges, should not exceed one-half of that of the short and light steam train displaced. There are about 1,000 of these now in operation in the United States. They cost from $25,000 to $50,000 each. About 37 oil-electric locomotives are in use and the Diesel-electric has been built recently.

The field of the self-propelled internal combustion type of rail cars and locomotives is not yet determined exactly. It is chiefly in light branch work, but the development of automobiles and buses has brought them into economical competition to replace rail service for this class of haulage. Air transport also is coming into the transportation field to affect the situation. It should also be noted that passenger traffic has decreased 33 per cent in the past nine years.

Advantages of electrification are direct and indirect

In the United States there are twenty different railway companies using electric traction. In all, 1,700 miles of route and 4,000 miles of track are in operation. These electrifications have been made for several purposes, such as suburban service, terminals in large cities, heavy grade haulage and main line haulage. It is reasonable to assume a further growth of electrification for these services where economic conditions warrant the developments.

Direct and indirect savings may be stated in favor of electrification. The direct savings are in motive power items and the indirect occur through changed methods of service and traffic stimulation.

Locomotive Repairs.—It has been difficult to allocate these costs between steam and electric. Based on known data and careful estimates, the gross cost of maintaining an equipment of electric locomotives needed to displace a larger number of steam locomotives should be one-third less. This factor of one-third in favor of electrics applies to full divisional operation.

Fuel.—No fixed percentage should be used, but for a large electrification recently figured, omitting power plant fixed charges, the cost of electrical energy was 70 per cent of the cost of fuel for steam locomotives based on an equal volume of traffic but higher speed electric operation.

Train and Engine Men.—Operating conditions govern this comparison. In general, the savings amount to about 4 per cent return on the net capital cost of the installation.

Miscellaneous Direct Savings.—The engine house expense under electric traction is between 20 and 30 per cent of that for steam locomotives. Lubrication and supplies are less for electric traction.

Indirect Savings and Advantages.—(1) Increased capacity of railroad. (2) Greater reliability on schedules. (3) Better utilization of rolling stock. (4) Reduction in station and miscellaneous expenses. (5) Reduction in track maintenance. (6) Elimination of smoke and gas. (7) Stimulation of passenger traffic.

The direct savings are in the form of energy cost, cost of maintenance of motive power and in train and engine labor. These savings, while large, will not in themselves warrant electrification, because they will not offset the fixed charges on the new capital involved. Thus changes in operating methods made possible by electrification and the stimulation of traffic are the deciding factors in each project. It is necessary, therefore, to make a complete economic study of each case before a decision can be made.

**Based on paper "The Economic Aspect of Railway Electrification," presented at the World Power Conference, Berlin, 1930.*

A New Epoch Through Research

Power industry ahead of scientific knowledge. Commercial, business and technical research problems. Time is at hand for new thinking and new equipment

By C. F. HIRSHFELD*

Detroit Edison Company, Detroit, Mich.

WE IN the power industry are, in our practical requirements, far ahead of the scientist. We need more knowledge regarding the fundamental composition of matter than the scientist is able to give us. We have advanced empirically far beyond the edges of the field which he has surveyed and properly measured, and our results would probably be more cheaply and more safely attained if we had available the more exact and more fundamental information that the scientist will some day be able to put into our hands.

When we speak of the power industry most people, and particularly engineers, think immediately of power production, transmission and distribution. Some few think of utilization. Still fewer think of the very complicated and equally important business, economic and social problems involved, particularly in the purveying of power by electricity supply companies. It is, however, true that these other problems are at least of equal, and sometimes of greater, importance than the technical ones. It is also true that they are just as susceptible to study by research methods. Unfortunately, much less research has been applied to them, and I am not sure but that our performance has lagged behind as a consequence.

The point I am making is well illustrated by the very different forms of electricity supply organizations that have been developed. Some are purely government owned and government operated. Some are government owned and operated by a commission more or less independent of political control. Some are stock companies in which much, but not all, of the stock is owned by government bodies, and operation is through executives elected by the stockholders. Some are privately owned, with their stock spread in very small parcels throughout the world or a large part thereof. Some are owned by large holding companies which possess part or all of the stock of subsidiaries and, in turn, issue stock of their own against such assets. And we might list on and on through an almost endless string of possibilities.

If one form were completely characteristic of the supply companies of one country or nation, one might assume it to represent the particular expression of the culture or ideals of that nation. While there are certain tendencies toward a conventional type in a few countries, we find nearly all types scattered widely. And we find very different types in contiguous territories, although these territories appear in all other respects similar. One is driven to the conclusion that we are here dealing with something so new that we are not yet out of the experimental state. One might say that we are still testing in practice the various possible social and economic theories regarding communal power generation and supply.

Surely there is here a rich field for research of the highest order. And it must be of the highest order if it is to be of value. It must be conducted by individuals bent on learning the truth and not on proving or disproving some pet theory.

Again, we find all forms and sorts of rates or tariffs underlying the contracts for power supply and the calculation of the bills rendered customers. Admitting that conditions vary greatly from place to place and from country to country and that the designing of rate schedules is, after all, a very complicated matter, influenced by many different factors in different locations, it does nevertheless appear that research might be applied very profitably in this field. We have many theories about rate structures, but I am not acquainted with any great amount of research work that has been done to prove or disprove the respective values of these theories.

And in the actual operation of the business end of the company there are many opportunities for research. What is the proper billing period? Obviously that which gives the best compromise between increasing cost

Based on paper "Research Relating to Power Development," World Power Conference, Berlin, 1930.

of meter reading and billing, which occurs with shortening of the period, and increased dissatisfaction on the part of the customers and losses through bad debts, which might be expected with too long a period. But, just where is the compromise attained. A decade or more ago the period was commonly accepted in the United States as one month. Now a two-month period is proving quite satisfactory and a lot cheaper in some of the representative cities. Surely there is room for research here.

Again, there are still in use in many cases antiquated business methods in those parts of the companies which have to do with routine matters of the business, such as accounting, keeping records of property owned, etc. All of these are proper and frequently profitable subjects for research.

So, it is obvious that this tool of the moderns is not to be limited to the engineering or technical aspects of the power business. In fact, because of the extent to which it has been used in the technical end and the extent to which it has been generally overlooked in the business end it is very apt to give the more valuable immediate results in the latter field.

Rich technical field

Research in the technical field may be profitably directed toward two inter-related but distinctly different problems—reducing the cost of service and improving the character of service. The cost of power, in the ultimate analysis, is made up almost entirely of capital charges, fuel charges and labor charges. And a given total reduction in any one of these is equally effective. I cannot get over the idea that engineers the world over have stressed inordinately the reduction of the fuel and labor charges and that they have failed to take proper cognizance of the capital charges.

The most obvious method for making progress in this direction in the steam power plant lies in the increase of the size of steam-generating units and in their improvement in such ways as will result in greatly lengthening the time between necessary shutdowns. It is not unreasonable to assume periods of operation as long as are now characteristic of the better turbines and attached generators. When the steam-generating part of the plant consists of a small number of units comparable with the number of turbine units and when these can be operated one or two years without shutdown, a radically different type of plant design and a radically lower investment per unit of plant capacity may be expected.

In the United States, in particular, such a movement is well advanced, but it has progressed largely by the adaptation of existing designs rather than by the invention of radically new ones. I feel that the greatest promise lies in the departure from past practice and in the production of equipment consciously planned from the beginning to meet new ideals and new demands.

Nor is the problem of combustion yet solved satisfactorily. We have made rapid advances in the design and operation of stokers and pulverized fuel-burning equipment. We are still faced, however, with many unsatisfactory limitations. We still use tremendously large and costly furnaces. We still burn stoker iron in addition to fuel. We still have to shut down a boiler frequently for the purpose of repairing the stoker. We still find the maintenance charges and outages of fuel pulverizing mills very troublesome. We still have not discovered any completely satisfactory method of catching and eliminating fly ash from the stack gases. And we have not found any commercial use for such material when we do catch it. None of our present combustion equipments meets the requirements of long-continued boiler operation without shutdown for repairs of some sort. Nor is any of it of such character as to lead to a belief in the early possibility of much lower investment.

Electrical research problems

On the electrical end things are equally bad. We still have to face the possibilities of disastrous arcs and other demonstrations of electric power out of control. And, in our efforts to minimize the costs and the extent of the serious consequences of such catastrophes, we have incurred tremendous investments for super-insulation and isolation of various sorts. In particular, we are never free from the fear that oil-filled circuit breakers will not only fail but will fail with a display of fireworks that will involve much additional equipment. And, even so, the oil circuit breaker in its present unsatisfactory form is indeed a costly piece of mechanism. We need a more satisfactory, a safer and a cheaper interrupting device. And we need some form of construction for the electrical ends of our generating plants and our substations which will with certainty, and at much lower first cost, prevent the concatenated phenomena that so frequently follow upon a minor breakdown. Here indeed are rich fields for research directed primarily to the discovery of electrical equipment and methods which will insure greater freedom from disastrous interruptions and at the same time reduce the costs. Thus far we have endeavored to accomplish the former by complications, duplications and additions which have all been responsible for increased investment.

And, as generating stations and systems have grown larger, we have begun to develop short-circuit possibilities of tremendous magnitude. This is best exemplified in the United States. It is doubtful whether the mere increase of size of circuit breakers and consequent increase of cost is a correct solution to the problems thus introduced. It seems more reasonable to assume that means will be found for designing systems which will preserve the desired operating flexibility and which, at the same time, will automatically limit the duty that can be placed upon any given breaker. A number of attemps have been made along these lines, but there appear to be many opportunities for further study and development.

As a matter of fact, we have in many of these matters drifted into a sort of blind following of fashion. This is indeed a grave accusation when applied to engineers in the practice of engineering. But I think that a bit of concentrated thought will show it to be correct. We are all greatly inclined to do what our predecessor has done, provided he has had reasonably successful results. And the outcome is, for example, that when one thinking and original engineer proposes that we shall build a power plant without the huge and costly overhead coal bunkers that we inherit from the days of unreliable coal-handling equipment he is looked at askance because he is varying from the norm. We really need much more original thought of that kind and more departures from the conventional.

No one can now say to what extent the first cost of the power plant and power system of the future may be

reduced by means of modifications such as those suggested above and by others not touched upon. After a fairly thorough study of the subjects, I find myself convinced that it will be found possible materially to reduce the cost of power supply through reduction of investment. In fact, I should not be surprised to find the saving effected by these means to be of about the same order of magnitude as the money value of the maximum thermal saving that now appears feasible. If my conclusions are correct, they indicate the desirability of devoting real study to means for reducing investment.

Nor need we end our comment on present limitations with the matters referred to above. The distribution of power is more and more forced underground. Here we invest in very costly structures principally because cable is so built that the insulation and not the copper determines the carrying capacity. It is a curious reflection upon our ability as inventors. We start with perfectly good copper conductors which if left unencumbered would be capable of carrying certain currents, and then we wrap them up in very temperamental insulating materials which are so sensitive to temperature that we greatly reduce the carrying capacity of the conductors.

It is at least conceivable that dielectric materials and types of construction could be discovered which would radically change this situation and the relations between cost and carrying capacity which are now accepted as normal. But such improvements are not as apt to come in the near future if we complacently accept the present relationships instead of consciously stating the possibilities of improvement and then starting research to make the possibilities into realities.

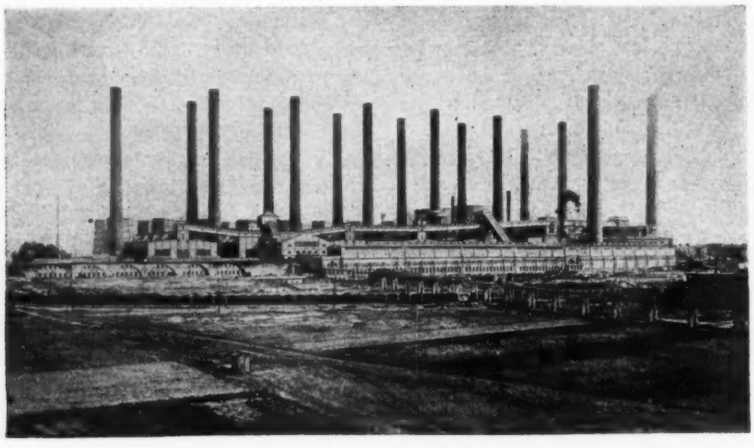
At the customer's end also

And at the customer's end of the line there are equal chances for reduction of cost and improvement of service. In the United States co-operation between lamp manufacturers and electricity supply companies has resulted in the development, manufacture and delivery of lamps of exceptionally uniform and desirable characteristics as to efficiency and life, at a marvelously low price. An effort is now being made to bring about similar results in the field of the smaller appliances, such as toasters, coffee percolators, flat-irons, and other well known and extensively used devices. And there is a real field for similar work in the case of larger appliances such as washing machines, cooking stoves and refrigerators. The cost of service, as the customer reckons it, is not confined to the power charge, but includes his investment in utilization equipment and his repair charges thereon. And there seems to be plenty of room for reducing the necessary investment while improving the quality and reducing the cost of repairs. Here again is a very extensive and promising field for research.

A new epoch approaches

It has been stated above that we are now in position to calculate, with a fair approximation to the truth, what is ultimately attainable with the methods now used for producing power. By this I do not mean that we can tell what is possible with any given assumptions regarding working substances and limiting maximum temperatures and pressures. I mean more than that. We can assume that the required metals will be available as needed and then calculate by means of applied thermodynamics just what is possible with different working substances in the presently used plant cycles.

If we may judge from human history, this indicates that we are approaching the end of an epoch. It means that somewhere around the corner of time there lies a radically different process for power development. It means that before we have quite reached the limit of possibilities with present methods the new method will appear as an undeveloped infant to be discussed and fought over and nourished and carried through the period of adolescence until finally we shall all say, "How simple, why did no one think of it before?"



Brown coal power plant, Golpa Zschornewitz

Men of the Industry

W. R. Burrows Chairman of G. E. Manufacturing Committee

VICE-PRESIDENT CUMMINGS C. CHESNEY, chairman of the manufacturing committee of the General Electric Company, will be relieved of his duties at his own request July 1, and will be

succeeded by Vice-President William R. Burrows. Since May 25, 1927, when Messrs. Chesney and Burrows were elected vice-presidents, they have been serving together as manufacturing officials of the company. Mr. Chesney is a pioneer in the electrical industry, having been associated in early life with the late William Stanley, who developed the transformer. He has seen more than 42 years of continuous service with the General Electric and Stanley companies. Upon retiring he will visit, during the summer, many of the plants of companies associated with General Electric in Europe.

Mr. Burrows, whose boyhood home was in Lynn, Mass., and who studied for a year at Massachusetts Institute of Technology, worked for the old Thomson-Houston Electric Company, one of the predecessors of General Electric, for several years. Beginning in 1894 he was given employment by S. E. Doane, formerly of Lynn, then superintendent of the Edison Lamp Works at Harrison, N. J. After a short time Mr. Burrows was promoted to supervising inspector of the various steps in the manufacture of incandescent lamps.

At this point Mr. Burrows became interested in the development of manufacturing processes and in the improvement of existing processes and by 1897 he was general foreman of the entire plant under George F. Morrison, superintendent. In that year he was transferred to the engineering department. He was attracted by engineering as applied to incandescent lamps, and with John W. Howell, engineer of the lamp works, did some important work in improving the methods of lamp manufacturing.

When Mr. Morrison was made a vice-president of General Electric in 1917, Mr. Burrows was appointed works manager of the Edison Lamp Works. While in this position he conceived and directed the development of the single-unit method in lamp manufacturing, resulting in great savings and increased manufacturing efficiency. In 1925, when the Edison Lamp Works at Harrison and the National Lamp Works at Cleveland were merged, Mr. Burrows was appointed associate manager, with T. W. Frech, of the incandescent lamp department of General Electric.

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S. N. Clarkson Resigns

STEWART N. CLARKSON has resigned as assistant to the director of the National Electrical Manufacturers' Association and established offices of his own in New York, for the purpose of rendering an intimate trade association service to manufacturers. Mr. Clarkson's activities have been devoted to the merchandising, manufacturing and public utility branches of the electrical industry. After leaving Sydney (Australia) Technical College he was with the Westinghouse Electric & Manufacturing Company from 1906 to 1910, when he became connected with North American Company properties for eight years.

Mr. Clarkson left the public utility field to become associate Western editor of *Electrical Merchandising* and the ELECTRICAL WORLD, which work he maintained until 1921, when he was appointed executive secretary of the Electrical Power Club. With this association he remained until its consolidation into the National Electrical Manufacturers' Association in 1926. During the past three years Mr. Clarkson has organized into co-operative trade association groups manufacturers of furnaces, refrigerators, carbon brushes, molded products, lighting equipment and signaling apparatus. He is active in industry affairs and is past-chairman of the St. Louis section of the American Institute of Electrical Engineers.

E. F. Pearson Named Chief Engineer

E. F. PEARSON, formerly electrical engineer of the Northwestern Electric Company, Portland, has been appointed chief engineer of that company. A native of Virginia City, Nev., a graduate of the

University of Nevada, Mr. Pearson entered the employ of the Northwestern Electric Company as field and design engineer on transmission and distribution lines, later becoming assistant superintendent of that department. Following military service, he returned in 1919 to the Northwestern organization in the capacity of electrical engineer and for the past six years has been in charge of electrical and structural engineering, machine design and general construction work. He is a past-chairman of the Portland section, American Institute of Electrical Engineers. For several years he has been active in the engineering section of the Northwest Electric Light & Power Association, holding several committee chairmanships and acting as section vice-chairman during the past two years.

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JOSIAH T. NEWCOMB, head of the Washington office of the Joint Committee of National Utility Associations, was made the recipient of the degree of doctor of philosophy by George Washington University. Mr. Newcomb received this honor in recognition of the special studies he has made in economics, sociology and history. He was formerly

a Washington correspondent for the Associated Press and more recently was a member of the New York State Senate.

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HARRY E. CLIFFORD, the Gordon McKay professor of electrical engineering since 1909, has been chosen dean of the Harvard Engineering School, to succeed Hector J. Hughes, who died March 1. He will take office immediately upon his return from abroad. Professor Clifford was educated at the Massachusetts Institute of Technology and at Harvard and from 1895 to 1909 he taught at M. I. T. Last year, when Dean Hughes left on sabbatical leave, Professor Clifford became acting dean of the engineering school, a position he held up to the present time. He is a fellow of the American Institute of Electrical Engineers, of which he is a past-chairman of the New England branch, and a member of the Illuminating Engineering Society, the American Association for the Advancement of Science and American Academy of Arts.

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Stickney and Oday Assume New Duties with Lamp Works

GEORGE H. STICKNEY, formerly the illuminating engineer of the Edison Lamp Works at Harrison, N. J., is now the consulting engineer for the Edison

G. H. Stickney

Lamp Works and National Lamp Works of the General Electric Company, with headquarters at Nela Park, Cleveland. A graduate of Cornell University, Mr. Stickney has a record of 34 years in the service of the General Electric Company in lighting work. He developed the familiar radial wave reflector for street lighting, the first semi-indirect units for use with the incandescent lamp and many devices for light control of both arc and incandescent lamps.

Mr. Stickney was one of the organizers and an early president of the Illuminating Engineering Society. He is a fellow of the American Institute of Electrical Engineers and American Association for the Advancement of Science, a member of the executive committee of the International Commission on Illumination and secretary-treasurer of the United States National Committee of the last-named body.

A. B. ODAY was formerly head of the lighting practice section of the engineering department of the Edison Lamp Works of the General Electric Company at Harrison, N. J. At the time of the consolidation of the engineering departments of the Edison Lamp Works and the National Lamp Works of the General Electric Company he was appointed executive engineer in charge of industrial, commercial and public lighting applications and related activities, which include railway lighting, floodlighting and lighting for outdoor sports, co-operation with lighting projects and with central-station lighting service departments.

Mr. Oday's business life has been devoted to illuminating engineering study and lighting practice work. He has served as general secretary of the Illuminating Engineering Society and has represented the industry in many educational and co-operative enterprises.

A. B. Oday

OBITUARY

Charles H. Kretz

CHARLES H. KRETZ, vice-president of the Public Service Company of Oklahoma, died May 4 at his home in Kansas City, Mo. Though Mr. Kretz removed from Okmulgee in 1927 to take charge of the operations of the City Ice Company, another subsidiary of the Middle West Utilities Company, he retained a vice-presidency in the Oklahoma company. Mr. Kretz had been active in utility circles in the Southwest for a number of years. His earliest connection was with the Baton Rouge Electric & Gas Company in the capacity of manager, later transferring his interests to Beaumont, Tex. In 1914 he became vice-president and general manager of the Oklahoma Power Company, subsequently consolidated with the Public Service Company of Oklahoma. Mr. Kretz was a native of Louisiana and was educated at Louisiana State University and at Cornell. For seven years he served on the faculty of his alma mater. Mr. Kretz served as president of the old Gas, Electric & Street Railway Association of Oklahoma fourteen years ago.

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HARRY DUNLAP, formerly president of the Lowell Electric Light Company, Lowell, Mass., died June 9 at his home in Billerica, Mass. He was an official of the A. G. Pollard Company, Lowell, Mass., and was president of the Billerica Trust Company. Mr. Dunlap was 72 years old.

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SAMUEL R. ARTMAN, 64 years old, long active in public affairs in Indiana and well known for his rulings as a member of the Indiana Public Service Commission, died recently of injuries sustained in a fall from the roof of his home in Lebanon. He was superintending some repair work on the roof when he slipped and fell headlong to the ground. Mr. Artman was known as a writer also and at the time of his death was completing a volume on the state's compensation law. He also had in preparation a book on "Hoosier Governors." In the course of his career he served in the Legislature as Speaker of the House, as judge of the Circuit Court at Lebanon and as chairman of the Indiana Industrial Board. In 1923 he was appointed a member of the Indiana Public Service Commission, remaining in that position six years, when he was named special assistant attorney-general, and as such had charge of all utility opinions that were handed down in that office.

Financial and Statistical News

LOW money rates, declining commodity prices and the stock market situation combine to provide the impetus for a strong bond market. New issues this year to date, however, have kept up well with demand, absorbing the surplus funds available.

——SEVERAL COMMON STOCK QUOTATIONS are in the neighborhood of the November low levels. Some of the rail issues got there first, but certain utility stocks are not far behind.

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North American Company to Increase Stock

A SPECIAL MEETING OF THE stockholders of the North American Company has been called for August 6, when a vote will be taken on a proposal to increase the authorized common stock to 50,000,000 shares of no-par value from 10,000,000 shares, to change 1,393,322 shares of authorized but unissued 6 per cent cumulative preferred stock into an equal number of shares of serial preferred stock of no-par value and to increase the serial preferred stock to 5,000,000. They will also vote on extending the corporate existence of the company. In commenting on the change Frank L. Dame, president, said:

There is no particular significance to be attached to my letter to the stockholders announcing a special meeting to be held on August 6. At that meeting the stockholders will vote upon amendments to the charter of the company providing for a 50-year extension of its corporate existence, increasing the authorized common stock, limiting the 6 per cent preferred stock to the amount now outstanding, and creating new preferred stock issuable in series from time to time as may be most advantageous. The growth of the company during its 40 years, and particularly during the past ten years, indicates the necessity of making substantial provision for its future development. Notwithstanding the fact that the company is not now required to do any financing, we believe that provision for the continued development of the company should be made some time in advance of the expiration of the charter ten years hence.

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May Revenue Rises 2 per Cent

A SLIGHT, though definite, increase in electric light and power revenue is evident in the reports thus far received by the ELECTRICAL WORLD for May, 1930, compared with the same month in 1929. Present indications point to a gain of about 2 per cent and to a 1 per cent rise in the number of kilowatt-hours sold.

The excess over 1929 has been continuously diminishing since the beginning of the year, for two major reasons: The growth during 1930 has clearly been less than usual; industrial activity during the spring of 1929 was exceptionally great—in fact, it is quite clear in retrospect that it was overstimulated, with the customary consequences, so that all our comparisons are made against an abnormally high base.

Only a tentative analysis is at present possible as to regional conditions. On the whole, the gain, small as it is, has been notably uniform, though the South seems to be doing a little better than the North.

The chief exception is in the East North Central States, where the depression continues: The revenue of the reporting companies was about 3 per cent less than it was a year ago, and the energy sales fell off by a somewhat greater percentage. This is the group of states in which the automobile industry is largely concentrated.

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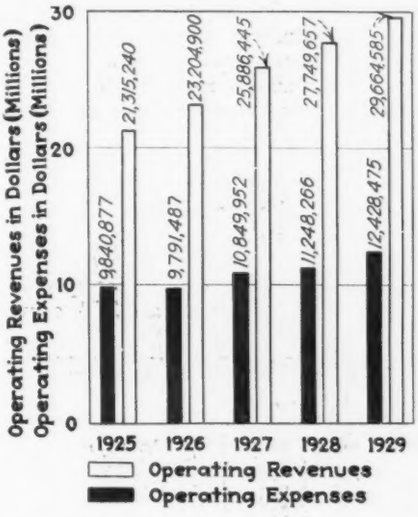
Boston Edison Shows Steady Growth

THE annual report of the Edison Electric Illuminating Company of Boston, recently submitted to its stockholders, reveals an encouraging trend in both physical and revenue departments.

In the past year customers' meters installed exceeded 400,000, a gain of nearly 7 per cent over that of 1928. During the year eleven customers contracted for over 1,000 kw. each, ranging up to 5,000 kw.; in addition, the total number of customers added was 25,097.



Comparison of revenue and expenses covering five-year period

For the first time the sales of electrical appliances exceeded $1,000,000 in the year 1929. During this year, through the reduction of rates put into force in 1928, the saving for last year amounted to approximately $1,300,000 to the customers of this company. The average rate paid by residence customers, numbering over 285,000, was approximately 6⅔ cents per kilowatt-hour, with a large group rating as low as 5½ cents and a considerable number as low as 3½ cents per kilowatt-hour.

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Electrical Development Progresses in Poland

THE SOCIÉTÉ BELGO-POLONAISE de Force et de Traction Electriques (Sobelpol) has issued a report for the year 1929, from which some interesting details regarding the progress of electricity supply in Poland can be gathered. It shows that the various power stations in the country controlled by the company have now a capacity of 61,500 kw. and that the output of power amounted to 103,930,487 kw.-hr., as compared with only 82,617,842 kw.-hr. in 1928. According to the latest fig-

ures, the consumption of electric energy now represents 78 kw.-hr. per year per inhabitant, as against only 61 kw.-hr. five years ago.

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Pacific Holding Company Enters Several Fields

STANDARD Management & Operating Corporation, newest subsidiary of the Standard Oil Company of California, has released details of its broad activities in the operation, supervision and development of public utilities and industrial establishments along the Pacific Coast. This organization will be available for public utility management, as well as engineering and construction work, and will conduct investigations and make appraisals of industrial plants and utilities.

Among the companies already successfully operated by Standard Management & Operating Corporation are: Pacific Public Service Company, Coast Counties Gas & Electric Company, California Consumers Company, California Consolidated Water Company, Coast Natural Gas Company; West Side Natural Gas Company, Inland Empire Gas Company, Natural Gas Corporation of California, Natural Gas Corporation of Oregon and Natural Gas Corporation of Washington.

Executives of the corporation include: E. F. English, president; E. A. Olsen, vice-president; R. N. Dreiman, treasurer, and Charles Grunsky, chief engineer.

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NEW CAPITAL ISSUES

Cities Service Company issued 5 per cent convertible gold debentures at 100 and interest, a piece of financing involving a total of $118,115,600. Each debenture will be convertible at the holder's option at any time from December 1, 1930, to December 1, 1935, inclusive, into common stock. The entire proceeds of these debentures will be applied to construction expenditures, additional investments and extensions and additions to the properties of the company and subsidiaries and to reimburse for advances already made for such purposes.

One hundred thousand shares of $6 cumulative preference stock of the Philadelphia Company were offered at $99.50 per share and accrued dividend. Proceeds from the sale of this issue will be used by the company for investments in its subsidiary companies and for other corporate purposes. This $6 cumulative preference stock will be followed by the common stock, dividends on which have been paid in each year since 1885 (except only 1897) at rates averaging over 6 per cent per annum.

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April Output in Canada Sets Record

OUTPUT OF CENTRAL ELECTRIC STATIONS in Canada during April created a new high record for any month in the history of the industry. Production in that month amounted to 1,645,122,000 kw.-hr., of which 1,623,942,000 kw.-hr. was generated by water power and 21,180,000 kw.-hr. by fuel. This compares with 1,507,902,000 kw.-hr. in March, 1930, and with 1,409,081,000 kw.-hr. in April, 1929.

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Earnings Maintained on High Plane

THE EXTENT TO WHICH some of the leading electric light and power companies have been hit by the current business recession is indicated by the probable 1930 earnings of these companies as estimated by the Standard Statistics Company based upon earnings for the first quarter or known operations of the various companies. The estimated average earnings per common share during 1930 by nineteen holding companies is placed at $3.32, against $3.02 in 1929 and $2.80 in 1928. Operating companies are not expected to do quite so well as the holding companies. The average earnings per common share of fourteen operating companies during 1930 is estimated at $7.54, compared with $7.61 in 1929 and $7.45 in 1928.

A list of these companies with their 1930 earnings as estimated by the Standard Statistics Company is given in the table below.

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NEWS BRIEFS

Pacific Gas & Electric Company has added to its directorate James B. Black and Edwin Gruhl of the North American Company and Guy C. Earl of the Great Western Power Company.

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During the last week or so Electric Bond & Share Company has been a buyer of substantial amounts of common stocks of American & Foreign Power Company Inc., American Power & Light Company, American Gas & Electric Company, Electric Power & Light Corporation and National Power & Light Company. These five companies are associated with Electric Bond & Share Company.

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New York Stock Exchange has authorized the listing on or after July 1 of not exceeding 4,705 additional shares of common stock of the Federal Light & Traction Company on official notice of issuance as a stock dividend, making the total amount applied for 475,333 shares.

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Kansas Gas & Electric Company has called for redemption, subject to the issuance and sale of an issue of new bonds, on September 1, 1930, all the outstanding first mortgage sinking fund 6 per cent gold bonds, series A, at 106 and interest.

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Stockholders of the Virginia Electric & Power Company will vote June 30 on approving a proposed change in the authorized capital stock so that there will be authorized 3,500,000 shares of common stock of no par value and 260,000 shares of $6 preferred stock of no par value, each present share of 7 per cent preferred stock to be exchanged for 1⅛ shares of $6 preferred stock, each present share of 6 per cent pre-

EARNINGS PER COMMON SHARE

Holding Companies

	1928	1929	1930 (Estimated)
American Power & Light	3.93	5.12	5.00
American Water Works & Elec	2.95	3.90	4.25
Columbia Gas & Elec	2.23	2.49	3.00
Commonwealth & South. Corp	0.58	0.75	0.90
Elec. Pwr. & Lt. Corp	2.37	2.98	3.35
Engineers Pub. Serv. Co	2.05	2.55	3.00
Federal Light & Trac	2.66	2.89	3.20
Middle West Utilities Co	1.57	1.81	2.00
National Power & Light	1.93	2.17	2.25
Niagara Hudson Pr. Corp		0.61	0.80
No. Amer. Co	3.89	4.58	5.25
Public Serv. Corp. of N. J	3.51	3.99	4.25
Standard Gas & Electric	6.63	7.01	7.00
United Corp. (Del.)		0.49	0.95
United Gas Imprvmt Co	1.27	1.46	1.85
United Light & Pwr	1.54	2.32	2.60
Utilities Pwr. & Lt	2.42	2.38	3.00

Operating Companies

	1928	1929	1930 (Estimated)
Brooklyn Union Gas Co	8.09	7.66	8.00
Commonwealth Edison Co	12.80	12.97	12.00
Consolidated Gas of N. Y	4.52	4.75	5.25
Cons. Gas El. L. & P. Balt	5.49	6.44	7.00
Detroit Edison Co	14.05	12.62	11.50
Edison Elec. Ill. Co	12.24	13.59	14.00
Montreal Lt. H. & P. Cons	1.93	2.14	2.25
Pacific Gas & Electric Co	3.17	3.52	3.75
Pacific Lighting Corp	4.22	4.54	5.50
Penna. Water & Power Co	3.84	4.37	4.50
Public Serv. Co. of No. Ill	15.84	16.04	13.50
Shawinigan Wtr. & Pr. Co	2.83	2.53	2.70
Southern California Edison	3.02	3.36	3.66

CURRENT EARNINGS REPORTS OF ELECTRIC LIGHT AND POWER COMPANIES

	1930	1929	Per Cent Increase	Operating Ratio 1930	Operating Ratio 1929
American Water Works & Electric & Subs. (Year ended April 30)					
Gross earnings	$54,849,143	$51,794,332	5.9	50	50
Net earnings	27,297,365	25,594,032	6.7	..	..
Arkansas Power & Light (Year ended April 30)					
Gross earnings	8,638,679	7,513,150	15.0	52	52
Net earnings	4,127,440	3,586,336	15.0	..	..
Associated Gas & Electric System (Year ended April 30)					
Gross earnings	103,846,695	52,618,711	97.0	50	55
Net earnings	52,072,675	23,818,643	118.0	..	..
Carolina Power & Light (Year ended April 30)					
Gross earnings	9,091,716	9,166,301	—1.0	46	46
Net earnings	4,959,303	4,906,946	1.0	..	..
Central Illinois Light (Year ended April 30)					
Gross earnings	5,235,112	4,870,894	7.5	57	59
Net earnings	2,237,455	2,000,026	11.8	..	..
Commonwealth & Southern (Year ended April 30)					
Gross earnings	147,383,426	140,960,398	4.6	49	50
Net earnings	75,344,026	71,563,982	5.3	..	..
Consumers Power (Year ended April 30)					
Gross earnings	33,329,533	31,777,147	4.9	48	49
Net earnings	17,259,983	16,113,792	7.1	..	..
Dallas Power & Light (Year ended April 30)					
Gross earnings	5,210,726	4,899,497	6.0	46	46
Net earnings	2,785,466	2,675,646	4.0	..	..
Detroit Edison (Year ended May 31)					
Gross earnings	56,142,541	54,855,230	2.3	67	65
Net earnings	18,529,590	19,170,095	—3.3	..	..
Eastern Texas Electric & Subs. (Year ended April 30)					
Gross earnings	9,993,977	8,592,180	16.3	..	..
Net earnings	4,198,841	3,573,263	17.5	..	..
Engineers Public Service & Constituent Cos. (Year ended April 30)					
Gross earnings	51,634,177	39,277,328	31.4	57	58
Net earnings	22,274,587	16,547,977	34.6	..	..
Federal Light & Traction & Subs. (Year ended April 30)					
Gross earnings	8,450,356	8,169,951	3.4	57	59
Net earnings	3,588,859	3,348,080	7.2	..	..
Galveston-Houston Electric & Subs. (Year ended April 30)					
Gross earnings	5,132,693	5,256,439	—2.3	..	..
Net earnings	1,633,719	1,711,453	—4.5	..	..
Houston Light & Power (Year ended April 30)					
Gross earnings	$8,312,850	$7,458,890	11.0	..	..
Net earnings	4,024,411	3,337,638	21.0	..	..
Kansas City Power & Light (Year ended April 30)					
Gross earnings	14,622,994	14,052,542	4.1	50	51
Net earnings	7,352,859	6,878,750	6.9	..	..
Kansas Gas & Electric (Year ended April 30)					
Gross earnings	6,009,395	5,486,617	10.0	52	54
Net earnings	2,844,270	2,521,910	13.0	..	..
Louisiana Power & Light (Year ended April 30)					
Gross earnings	5,587,475	4,287,118	30.0	52	52
Net earnings	2,668,503	2,056,548	30.0	..	..
Memphis Power & Light (Year ended April 30)					
Gross earnings	6,598,294	5,928,803	11.0	60	59
Net earnings	2,644,156	2,408,151	10.0	..	..
Pennsylvania Power & Light (Year ended April 30)					
Gross earnings	30,505,347	29,145,013	5.0	50	50
Net earnings	15,383,803	14,644,678	5.0	..	..
Public Service Corporation of New Jersey & Subs. (Year ended May 31)					
Gross earnings	138,623,441	130,069,764	6.6	..	..
Net earnings*	42,603,477	39,127,935	8.9	..	..
Puget Sound Power & Light & Subs. (Year ended April 30)					
Gross earnings	16,791,355	15,505,676	8.3	..	..
Net earnings	7,105,721	6,426,418	10.5	..	..
Southern California Edison (Year ended April 30)					
Gross earnings	40,722,533	36,801,481	11.0	33	34
Net earnings	27,229,593	24,101,968	13.0	..	..
Tampa Electric & Subs. (Year ended April 30)					
Gross earnings	4,588,882	4,636,421	—1.2	..	..
Net earnings	1,507,388	1,493,311	0.9	..	..
Tennessee Electric Power & Subs. (Year ended April 30)					
Gross earnings	15,198,889	13,712,553	10.8	51	51
Net earnings	7,496,025	6,703,706	11.9	..	..
Utah Power & Light (Year ended April 30)					
Gross earnings	11,759,016	11,291,114	4.0	51	49
Net earnings	5,752,736	5,789,017	—1.0	..	..
Virginia Electric & Power & Subs. (Year ended April 30)					
Gross earnings	17,142,115	16,539,503	3.7	..	..
Net earnings	7,772,508	7,305,797	6.4	..	..

*After operating expenses, maintenance, taxes and depreciation.

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ferred stock to be exchanged for one share of $6 preferred stock, and each share of common stock to be exchanged for five shares of new common stock.

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Canada Doubles Output in Five Years

THE OUTPUT OF CENTRAL electric stations in Canada during 1929 amounted to over 18,014,000,000 kw.-hr., including estimated quantities for small stations which do not make monthly returns, according to a report on the "Production and Use of Electric Energy in Canada," published by the Dominion Bureau of Statistics. The large stations, which generate between 97 and 98 per cent of the total, reported 17,625,900,059 kw.-hr., or an increase of 10.6 per cent over the 1928 output and almost double the output for 1924.

The rapid increase in the production of electric energy by central electric stations is stated to be due largely to the growth of the pulp and paper industry. In 1924 the motors in the pulp and paper mills operated on power purchased from central electric stations had a rated capacity of 315,464 hp., or 12.4 per cent of all power equipment in manufacturing industries (the central electric station industry excluded), and in 1927 their rated capacity had more than doubled, increasing to 789,530 hp., which was 24 per cent of the total power for all industries.

Also the pulp and paper industry has been using an increasing amount of electricity for heating water and practically all the electric energy is used 24 hours per day throughout the year, as against an average working day for other manufactures of eight to nine hours.

Although the low rates are important factors in increasing the average consumption per capita for all purposes to 1,845 kw.-hr., which is more than twice the average in the United States and almost ten times the average in Great Britain, the large consumption by the pulp and paper industry is the main factor.

Exports amounted to 1,444,208,440 kw.-hr., about two-thirds coming from the Niagara region.

The report gives further details on power production and also contains statistics on power equipment in Canadian industries.

Kilowatt-Hours Generated by Provinces, 1929

Reported by Larger Stations

Province	Water	Fuel	Total
Prince Edward Island	.....	1,968,769	1,968,769
Nova Scotia	88,767,170	17,657,279	106,424,449
New Brunswick	96,433,384	29,273,095	125,706,479
Quebec	8,677,204,000	91,525	8,677,295,525
Ontario	6,138,487,711	8,804,200	6,147,291,911
Manitoba	1,109,129,650	5,072,500	1,114,202,150
Saskatchewan	.....	109,051,667	109,051,667
Alberta	107,285,367	95,933,524	203,218,891
British Columbia	1,077,128,505	63,611,763	1,140,740,268
Total	17,294,435,787	331,464,322	17,625,900,109

Business News and Markets

Electrical Manufacturing Under Last Year

FOR the first time in 2½ years the rate of productive operations in the electrical manufacturing industry has fallen under that for the same month of the year previous. The May rate of operations of the industry as a whole based on the monthly consumption of electrical energy by these plants was 4.2 per cent under April and 3.4 per cent under May last year. The April-May decrease in operations was about 5.1 per cent greater than the normal drop for this season of the year. For the first five months of the year, however, a gain of 6.3 per cent was recorded over the same period last year.

The middle of the second quarter finds the larger electrical manufacturing companies in a slightly more favorable position than the group of smaller companies, although both groups recorded a drop in activity during May as compared with April. The group of larger companies recorded a May decrease of 6.3 per cent as compared with April, but was still operating at a rate about the same level as during May last year. Activity in the group of smaller electrical manufacturing companies is not so favorable. This group recorded a decrease in operations during May of 3 per cent and was operating on a plane 7.8 per cent under May last year.

Comparative indexes of productive activity in the electrical manufacturing industry based upon the consumption of electrical energy by these plants, adjusted for number of working days and referred to the period 1923-25 as 100, are shown in the accompanying table.

May, 1930	158.0
April, 1930	164.9
March, 1930	153.0
February, 1930	165.2
May, 1929	163.5
Average first five months 1930	160.6
Average first five months 1929	151.1

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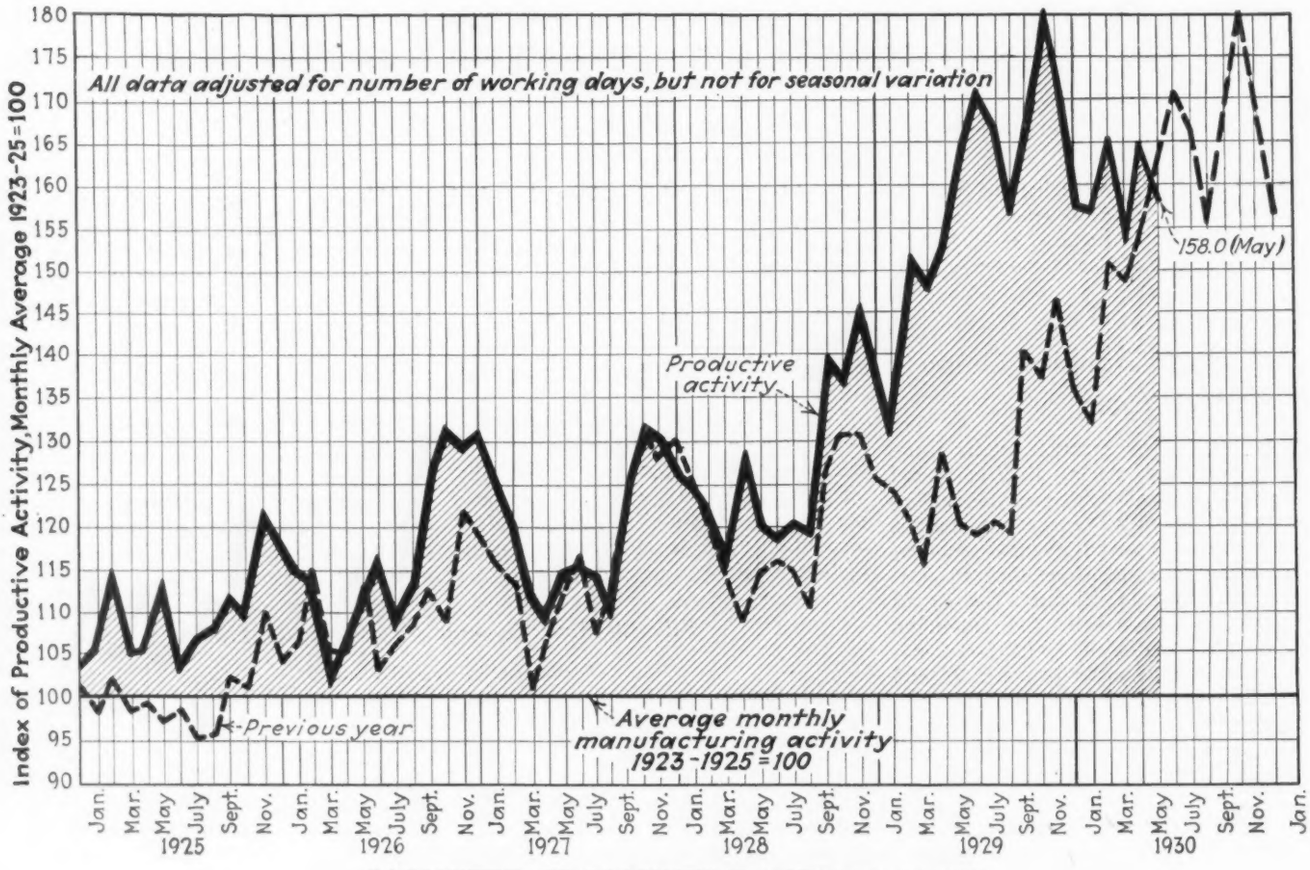
English Electric Appoints New Board Members

FOUR NEW DIRECTORS have been appointed to the board of the English Electric Company, Ltd., and three former directors have resigned in accordance with the scheme for the reorganization of the capital of the undertaking. The new directors are F. Massingberd Rogers, managing director of the Greater London & Counties Trust; Sir Edward Hilton Young, D.S.O., D.S.C., M.P.; Percy Horsfall of Lazard Brothers & Company, Ltd., and Colonel Wade Hampton Hayes of Chase Securities Corporation.



BAROMETER OF PRODUCTIVE ACTIVITY IN THE ELECTRICAL MANUFACTURING PLANTS OF THE UNITED STATES

The retiring directors are Sir Charles E. Elles, Sir John A. F. Aspinall, D.Eng., M.I.C.E., and Lieut.-Col. Sir John H. Mansell.

The Greater London & Counties Trust is controlled by Utilities Power & Light Corporation (Virginia), and in turn controls a long list of electric supply companies in Britain. Lord Birkenhead, former Lord Chancellor, is chairman.

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Westinghouse Gets Locomotive Order

DIRECTOR-GENERAL J. Lagarrigue of the Chilean State Railways recently telephoned an order from Santiago, Chile, to the New York office of the Westinghouse company for four express passenger locomotives which have a value of about $500,000. Ordinarily negotiations of this sort are carried on by letter or cable and would involve a delay of weeks or months.

1930 Estimated Earnings Show Decline

THE EXTENT TO WHICH some of the leading electrical equipment manufacturing concerns have been hit by the current business depression is indicated by the probable 1930 earnings of these companies as estimated by the Standard Statistics Company based upon earnings for the first quarter or known operations of the various companies. The estimated average earnings during 1930 of eleven large electrical manufacturing companies is placed at $3.76 per common share, against $4.69 in 1929 and $3.87 in 1928. Six concerns reported average earnings for the first quarter of only $0.22, compared with $1.03 for the first quarter of last year, according to Standard Statistics.

Earnings per Common Share

	1928	1929	1930
American Brown Boveri	1.04	0.32	....
Black & Decker Mfg. Co.	3.18	3.51	3.00
Claude Neon Lights, Inc.	....	1.05	1.50
Crocker-Wheeler Elec. Mfg. Co.	0.36	1.75	1.90
Cutler-Hammer, Inc.	4.37	8.14	8.00
Electric Storage Battery	7.10	8.77	6.00
Formica Insulation Co.	2.82	5.51	4.00
General Cable Corp.	2.90	4.20	1.00
General Electric	1.78	2.24	2.50
Manhattan Elec. Supply Co.	d4.83	1.76	1.00
Westinghouse E. & M. Co.	8.78	10.15	8.00
Weston Elec. Inst.	2.55	4.49	4.50
Kelvinator Corp.	d0.89	1.03	4.00
Servel, Inc.	d0.05	d0.38	0.50
Airway-Electric Appliance	3.29	3.86	3.00
Eureka Vacuum Cleaner Co.	3.15	4.60	4.00
Maytag Co.	2.38	3.33	2.75

d—Deficit.

New York Metal Prices

	June 18, 1930 Cents per Pound	June 25, 1930 Cents per Pound
Copper, electrolytic	11.575	12
Lead, Am. S. & R. price	5.40	5¼
Antimony	5.10	7
Nickel, ingot	35	35
Zinc, spots	4.40	4.225
Tin, straits	29⅞	31⅛
Aluminum, 99 per cent.	24.30	24.30

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EXPORTS OF ELECTRICAL EQUIPMENT (PRELIMINARY)

Article	April 1929	April 1930
Generators:		
Direct current—		
Under 500 kw.	111,041	41,884
500 kw. and over	39,333	40,084
Alternating current—		
Under 2,000 kva.	16,633	43,979
2,000 kva. and over	.....	126,988
Steam turbine generator sets	20,074	71,165
Accessories and parts for generators	48,438	83,146
Arc welding sets	.....	48,645
Self-contained lighting outfits	93,713	78,030
Batteries:		
Storage batteries	341,817	.....
6-volt storage batteries	.....	164,921
Other storage batteries	.....	96,259
No. 6 dry cell batteries	.....	49,061
Flashlight batteries	378,673	316,338
Radio B and C batteries (dry)	71,439	50,355
Other dry and wet cell primary batteries	171,840	19,954
Transforming or converting apparatus:		
Power transformers, 500 kva. and over	50,352	209,223
Distribution transformers, less than 500 kva.	109,953	185,707
Instrument transformers	17,240	18,060
Other transformers	87,054	84,081
Complete battery chargers under 15 amp.	18,414	11,311
Rectifiers, double current and motor generators, dynamotors, synchronous, and other converters	63,702	92,303
Transmission and distribution apparatus:		
Switchboard panels, except telephone	84,665	176,309
Switches and circuit breakers over 10 amp.	171,168	169,634
Fuses	40,188	30,205
Watt-hour and other measuring meters	121,008	54,942
Electrical indicating instruments	53,098	75,064
Electrical recording instruments	21,939	30,431
Other electrical testing apparatus	71,065	78,308
Lightningarresters, choke coils, reactors, and other protective devices	126,330	103,061
Motors, starters and controllers:		
Motors, ¼ hp. and under	207,643	197,502
Motors, over ¼ and under 1 hp.	93,335	49,050
Stationary motors—		
1 to 200 hp.	417,561	303,387
Over 200 hp.	17,368	60,041
Railway motors	4,829	28,475
Electric locomotives—		
Railway	3,600	20,783
Mining and industrial	59,791	51,738
Station and warehouse electric motor trucks	18,610	18,324
Starting and controlling equipment—		
For industrial motors	197,758	133,643
For electric railway and vehicle motors	1,300	11,538
Portable electric tools	99,200	90,420
Accessories and parts for motors	274,930	208,069
Refrigeration sets up to ½ ton capacity	1,184,456	.....
Refrigeration sets over ½ to 1 ton capacity	178,289	.....
Electric household refrigerators	.....	1,240,459
Electric commercial refrigerators up to 1 ton capacity	.....	255,685
Thermodynamic refr'gt'rs	.....	265
Electric appliances:		
Electric fans	109,859	158,943
Electromechanical health exercisers	.....	18,843
Electric incandescent light bulbs—Metal filament	93,176	.....
For automobiles, flashlights, and Christmas trees	.....	17,901
Other metal filament bulbs	.....	109,583
Other electric lamp bulbs	40,719	39,009
Flashlight cases	285,795	142,749
Searchlights and floodlights	42,157	55,538
Motor-driven household devices—		
Electric household washing machines	233,075	163,650
Electric vacuum cleaners	67,402	204 818
Other motor-driven devices, except tools	124,553	101,088
Electric flatirons	38,637	23,033
Electric cooking ranges	29,734	21,569
Other domestic heating and cooking devices	80,934	86,095
Industrial electric furnaces and ovens	27,897	59,372
Therapeutic and x-ray apparatus	174,522	142,307
Signal and communication devices:		
Radio apparatus—		
Transmitting tubes, sets, and parts	63,075	147,384
Receiving sets	343,111	649,294
Radio receiving tubes	126,674	163,461
Receiving-set components	207,723	217,686
Loudspeakers	131,058	133,704
Other receiving-set accessories, not elsewhere specified	127,707	116,736
Telegraph apparatus	57,598	53,727
Telephone apparatus—		
Telephone instruments	96,386	44,874
Telephone switchboards	204,811	39,194
Other telephone equipment	226,307	380,081
Bells, buzzers, annunciators and alarms	27,345	35,141
Other electric apparatus:		
Spark plugs	214,192	105,582
Other starting, lighting, and ignition equipment	215,102	174,307
Insulating material	108,343	95,110
Metal conduit, outlet, and switch boxes	111,496	109,833
Sockets, outlets, fuse blocks, and lighting switches	183,400	153,217
Electric interior lighting fixtures	231,950	170,632
Electric street lighting fixtures	54,559	25,470
Other wiring supplies and line material	92,246	122,154
Other electrical apparatus not elsewhere specified	1,554.968	742,087
Rubber and friction tape	49,996	39,176
Globes and shades for lighting fixtures	65,385	50,654
Glass electric insulators	46,584	30,683
Electrical porcelain:		
For less than 6,600 volts	79,637	56,757
For 6,600 volts and over	101,134	125,923
Carbons and electrodes:		
Electrodes for electric furnaces	200,038	144,946
Other carbon products	91,676	65,456
Insulated iron or steel wire and cable	20,778	21,333
Copper, bare wire	256,533	280,828
Insulated copper wire and cable	468,881	.....
Rubber covered wire	.....	87,131
Weatherproof wire	.....	14 321
Telephone cable	.....	19,362
Other insulated copper wire	.....	274,000
Totals	$12,194,998	$11,453,561
Four months ended Apr. 30	$47,756,667	$48,624,515

Market Conditions

EQUIPMENT sales in the Eastern district are reported to have declined in the case of small manufacturers and well sustained by larger manufacturers. Pacific Coast business is decidedly limited and competition is keen for such orders as do exist.

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SOUTHEAST

—BUSINESS IN THE SOUTHEAST *was again confined to routine demands during the past week, with the exception of the letting of an airport installation at Greenville, S. C., and numerous inquiries for lighting equipment for baseball fields over the section.*

A Georgia construction company ordered five carloads of weatherproof wire from one manufacturer and 300,000 lb. of bare wire from another, six 150-kva. transformers and miscellaneous items amounting to $3,000. A Georgia utility company ordered wire in the amount of $25,900; low-tension transformers, $3,300; pole-line equipment, $4,000; meters, $2,000; switches and other miscellaneous equipment, $2,500. An Alabama utility company received quotations on 30 miles of No. 2/0 transmission wire, and utility companies in Georgia ordered approximately 200,000 lb. of bare wire.

CONSTRUCTION PROJECTS

Southern Mineral Products Corporation, Afton, Va., plans mineral mining and refining plant, including power house, to cost $1,000,000. National Consumers Oil Company, Terre Haute, Ind., plans oil storage and distributing plant at Louisville, Ky., to cost $200,000. Aluminum Company of America, Inc., Pittsburgh, Pa., contemplates hydro-electric power plant near Tuckerton, N. C., to cost over $3,000,000. Crisp County Power Commission, Cordele, Ga., will build power plant to cost over $100,000.

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MIDDLE WEST

—MAJOR ACTIVITIES, *steel, railroad, automotive and electrical industries, continue to mark time, with some slight recessions noticeable. The large mail order houses show a seasonal gain in sales over the last period, although somewhat below a corresponding period last year. The various utility companies are proceeding conservatively with as much construction and expansion as conditions will permit.*

Some of the interesting orders placed this week include a contract for heating and ventilating equipment to cost $100,000, cable to cost $130,000, chlorinating equipment to cost $17,000, two regulating transformers, three-phase, 60-cycle, oil-immersed, self- and forced-air cooled, to cost $50,000, and several construction orders aggregating $75,000.

CONSTRUCTION PROJECTS

Wisconsin Hydro-Electric Company, Amery, Wis., plans transmission line from Cumberland, Wis., to Pine City, Minn., to cost over $75,000. Sturgis, Mich., plans addition to municipal hydro-electric power plant to cost $75,000. Ford Motor Company, Dearborn, Mich., will build addition to local power plant to cost $1,000,000, and will carry out other plant expansion to cost about $23,000,000. Constructing Quartermaster, Wright Field, Dayton, Ohio, is asking bids until July 12 for radio laboratory and other buildings. Harvey & Lakota, N. D., plan ornamental lighting systems. Caterpillar Tractor Company, Peoria, Ill., will build addition to plant at Minneapolis, Minn., to cost $200,000. Northern States Power Company, Minneapolis, Minn., will build addition to power plant to cost over $1,000,000. Northwestern Power & Light Company, Cedar Rapids, Iowa, plans addition to power plant at Grundy Center, Iowa.

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NEW ENGLAND

—NEW ENGLAND SALES ARE STEADY, *with small motors, general scheduled materials and line materials outstanding in market news. Heavy equipment orders receded and negotiations have slackened slightly. Manufacturers report a slight recession in electrical equipment orders during the past week.*

There is a steady demand for small motors. One prominent manufacturer records a number of interesting orders for small motors in lots, among which are groups amounting to $2,300 to $4,500 and another with control equipment amounting to about $8,250. Motor sales, it is reported, are maintaining an encouraging trend as compared with last year. General scheduled equipment orders are in fair volume; one manufacturer reports an increase in business volume this month as compared with last year. Central station supplies are spotty; transformer sales are less active. Substation needs are in some demand and insulator sales are steady. Pole and crossarm shipments by one distributor have been active. Line extensions in New Hampshire recently closed include a short 2,300-volt line into eastern New Hampshire. In addition, a short 13,200-volt line involved several orders for line materials in this district. Plans for further line extensions in southeastern Maine are contemplated. A contract involving approximately 12,000 hp. has been signed between a prominent textile company in eastern Maine and the Cumberland Light & Power Company. In northeastern Maine a high-power transmission radio station estimated at $300,000 has been planned.

CONSTRUCTION PROJECTS

Mexican Petroleum Corporation, New York, plans storage and distributing plant at Chelsea, Mass., to cost about $150,000. Anaconda Wire & Cable Company, New York, plans expansion in plant of Weill-Barnfield Company, Providence, R. I., recently acquired.

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EASTERN

—DEMAND FOR ELECTRICAL EQUIPMENT *has a tendency to be spotty in the Eastern district, and while the larger manufacturers are securing a good quota of commitments, comparing favorably with this time last year, the smaller producers report decreased sales. There are plenty of inquiries—the difficulty is to close for the order. Electric railway equipment has recorded another encouraging volume of transactions for the week and indications point to early further business for this account.*

—CENTRAL-STATION DEMAND *easily takes the lead among all other lines of activity, with both steam and hydro-electric developments prominent.*

A central station in Missouri has placed an order with a New York manufacturer for switchgear, transformers and kindred apparatus to cost $200,000. A power company in New York has purchased similar equipment from the same maker costing $40,000. The city of Jackson, Tenn., has contracted with the General Electric Company for switchboards and accessories for a municipal power station, the order for the turbo-generator unit going to the Allis-Chalmers Manufacturing Company. A central station in West Virginia has purchased a quantity of oil circuit breakers, lightning arresters, etc., from a New York manufacturer to cost about $10,000. A Connecticut utility company has given a commitment for switchgear and accessory equipment to an amount of $30,000. Merchandising continues to show gains; one New England public service company reports an active demand for refrigerators in southern New

Hampshire; domestic household appliances are selling well.

Electrical manufacturers specializing in industrial equipment say that business is considerably below the average of last June. Inquiries are fair, but there is noticeable hesitancy in placing orders. Iron and steel mill account continues as one of the most active in the industrial field, while the development of oil pipe lines is running a close second for motors and controls, air compressors, engines and auxiliaries. The Westinghouse Electric & Manufacturing Company has secured an order for twenty synchronous motors and control equipment for pumping service on an oil pipe line between Oklahoma and Chicago. There are other heavy orders in sight for similar installations. Chemical plants show excellent revival and increased demand for equipment is ensuing.

The General Electric Company has secured a contract from the Philadelphia Rural Transit Company for generators, motors and auxiliaries for ten electric-drive buses for interurban service, geared for a maximum speed of 57 m.p.h. The Chicago, Burlington & Quincy Railroad Company has ordered five gas-electric rail motor cars from the Pullman Car & Manufacturing Company. The Electric Storage Battery Company has obtained a record commitment from the New York Central Railroad Company for 35 giant battery units for a new fleet of battery-oil-electric locomotives, totaling close to $4,000,000; each battery will weigh about 17 tons, and will have sufficient power to haul a line of freight cars. A manufacturer of electric stoves and boilers reports an order from a jobber on the Pacific Coast aggregating over $1,000,000 for a term of months.

CONSTRUCTION PROJECTS

General Electric Company, Albany, N. Y., has filed plans for factory branch, storage and distributing plant at Cleveland, Ohio, to cost $500,000. United States Steel Corporation, New York, will carry out expansion and improvement program at Carnegie Steel Company plants in Pittsburgh, Pa., district to cost $5,000,000. New York Central Electric Corporation, Geneva, N. Y., will make extensions in system to Birdsall and Grove, including installation of light and power systems. Shell Eastern Petroleum Products Company, New York, contemplates storage and distributing plant at Philadelphia, Pa., to cost over $150,000. Union Gulf Corporation, Pittsburgh, Pa., plans oil refining plant at Pittsburgh, and addition to refinery at Toledo, Ohio, to cost over $5,000,000. Davison Chemical Company, Baltimore, Md., will build plant at Pasadena, Tex., to cost $350,000. General Purchasing Officer, Panama Canal, Washington, D. C., will receive bids until July 8 for cable, motors, floodlighting projectors, and other electrical supplies (Panama Schedule 2569). Bureau of Yards and Docks, Navy Department, Washington, will receive bids until July 2 for a fire alarm system (Specification 6162.)

PACIFIC COAST

—CONTRACTORS REPORT VERY LITTLE *active work, with extraordinarily keen competition, and wholesalers report the same conditions in sale of standard conduit and wiring staples. This is reflected in comparative construction figures for first five months of 1930, which totaled $10,315,000 for San Francisco, $34,300,000 for Los Angeles and $4,710,000 for Oakland, as compared with 1929 figures, which totaled $15,000,000 for San Francisco, $46,100,000 for Los Angeles and $6,825,000 for Oakland.*

Power company purchases include a carload of cambric and park cable for Los Angeles, a 12-mile line for Eureka district, two carloads of hardware for Fresno—one covering 15,000 steel pins, the other an assortment of bolts, washers and guy clamps—$2,000 worth of 500,000-circ.mil rubber-covered wire for San Francisco, Westinghouse generator parts valued at $27,000 for Los Angeles, network protector material valued at $30,000 for Seattle, $35,000 worth of Westinghouse high-tension insulators and $20,000 worth of General Electric substation regulator, switching equipment and transformers to replace equipment lost in the recent Susanville fire. Industrial business covers a $3,000 generator switchboard for a Hawaiian plantation and $25,000 worth of elevator motors and controls for Los Angeles. Especially interesting have been range sales, covering two carloads for Seattle, a carload for Salt Lake City and a carload for Los Angeles. Commercial departments are now working on lighting and range campaigns. Government business includes electric cooking installation for Fort Mason in San Francisco, barracks for March Field in Riverside, a post office for Pomona and an 11,000-volt power line, costing $5,000, for San Francisco quarantine station. The week's outstanding order covers a $50,000 sale of Westinghouse meters, transformers and switching generators to a San Francisco industrial.

Bids opened May 31 by the city of Seattle for three 4,000-kva. transformers, ranging from approximately $14,000 to $17,000, and for four 37,000-volt oil circuit breakers, ranging from approximately $15,000 to $18,000, were rejected on June 20 and new bids will be invited. Plans for a city light steam plant in the industrial district costing $400,000 have been abandoned by Seattle and an enlargement of existing Lake Union steam plant is projected. Sand Point, Idaho, has received a license from the Federal Power Commission to construct a 700-hp. municipal lighting plant on Priest River and the Peoples Coast Hydro-Electric Corporation at Shelton, Wash., will spend approximately $10,000 in construction of a transmission line serving the Kamilche valley district. City of Tacoma on June 23 opened bids for approximately $20,000 worth of motors, ranging from 200 hp. down, for a steam auxiliary plant. Motor sales during the week were very light, orders involving approximately 40 machines, from 50 hp. down, to irrigation districts and dealers. Sales of four motor-generator sets, ranging from 7½ to 10 kw., and eighteen floodlighting sets, from 1,000 to 1,500 watts capacity, were reported. The city of Seattle is taking bids for 500 cedar poles, and Prosser, Wash., is taking bids until July 15 for one deep-well turbine pump.

CONSTRUCTION PROJECTS

Warner Brothers Pictures, Inc., Burbank, Calif., plans addition to motion picture studios to cost $3,500,000. Santa Barbara, Montebello, Santa Cruz and Norwalk, Calif., plan ornamental lighting systems. Fox Film Corporation, Movietone City, near Hollywood, Calif., plans expansion in motion picture plant to cost $4,000,000. Department of Utilities, Tacoma, Wash., will take bids for municipal power plant to cost $350,000. Yakima, Wash., plans ornamental lighting system. Trade Dollar Consolidated Mining Company, Silver City, Idaho, plans hydro-electric power plant on Snake River, to cost $200,000. Brigham City, Utah, plans municipal power plant. Inland Utilities Company, Stratton, Colo., plans steam-operated electric power plant to cost $90,000. Public Service Company of Colorado, Denver, plans 90,000-volt transmission line from Fort Lupton to Greeley, to cost over $100,000.

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SOUTHWEST

—CAREFUL BUYING BY UTILITY *operators and industrials has been the rule for the past week. Naturally the extremely hot weather has caused a boom in fan business.*

Among the contracts reported closed were electrical equipment for twenty street cars, $65,000; 590 street-lighting posts complete for $30,000; all materials for two white-way jobs, $22,000; 34 motors, 100 hp. and less, for factory use, $14,000, and a lot of motors for new roundhouse for one of the railroad companies, $3,000.

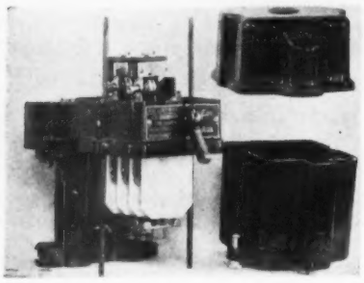
CONSTRUCTION PROJECTS

Kansas Power & Light Company, Topeka, Kan., plans power substation to cost $60,000. Stearman Aircraft Corporation, Wichita, Kan., plans plant to cost $200,000. Missouri Portland Cement Company, St. Louis, Mo., contemplates mill near Tulsa, Okla., to cost $2,000,000. Marlow, Okla., plans transmission line for municipal service. Rector, Ark., has approved plans for municipal power plant to cost $70,000. Cosden Refining Company, Big Spring, Tex., plans addition to oil refinery to cost $150,000. Texas-Louisiana Power Company, Fort Worth, Tex., will install ornamental lighting system at Spearman, Tex.

New Equipment Available

Breaker for Motors Up to 550 Volts

AN OIL CIRCUIT BREAKER, designated as type VHT, for small motors on circuits up to 550 volts and 1.5 to 25 amp., a.c. or d.c., has been placed on the market by



Voight & Haeffner of Frankfurt-am-Main, Germany, represented in New York by Bruno H. Ahlers.

Massive contacts, thorough insulation of the parts and a well-designed quick-break mechanism, assure reliable performance, the manufacturer states; currents of 3,000 amp. a.c. and 500 amp. d.c. have been successfully broken; in durability tests operation continued faultless after 200,000 repetitions.

The breaker includes two thermally retarded overload releases with direct action on short circuit. A separate relay chamber gives protection against fouling by the gases from the oil and makes possible a change of relay setting or even the replacing of the entire relay system without removing the oil tank. Escape of oil with the gases is prevented by the design of the vent.

▼

Push-Button Control for Motor-Generators

NEW SIMPLIFIED AUTOMATIC SWITCHING equipment, available for the control of the standard sizes of motor-generators for mining service, is announced by the Westinghouse Electric & Manufacturing Company. This equipment is for the control of 100, 150, 200 and 300-kw., 2,300-volt a.c., three-phase, 25 or 60-cycle, 250/275-volt or 600-volt d.c. motor-generator sets. The high-tension equipment, including the starting and running devices, current and potential transformers and their power interconnections, are mounted in a welded steel frame completely inclosed with removable steel plates. The cubicle provides protection for the employees against accidental contact with the high-tension circuit, protects the switching devices against abnormal atmospheric conditions and is a very compact arrangement.

The automatic switching equipment provides for the starting and stopping of the unit by means of a remotely mounted push button, or a control switch mounted on the switchboard. The motor-generator is connected to the auto-transformer for reduced voltage starting, after the starting impulse has been given by the closing of the push button, or the control switch, and relays indicate correct starting conditions. When the unit reaches synchronous speed, the generator voltage is built up, the synchronous motor field is excited and the motor is connected to the full line voltage. If the d.c. line conditions are normal, as indicated by the automatic reclosing equipment, the generator is automatically connected to the line.

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ELECTRIC FURNACE STEEL has been adopted as standard for the manufacture of all "copperweld" wire strand and ground rods by the Copperweld Steel Company, Glassport, Pa. As a result of this latest development, greater safety and, therefore, greater economies are now available in overhead construction, as the tensile strength standards of these wires and strands are raised to higher permanent levels, it is claimed.

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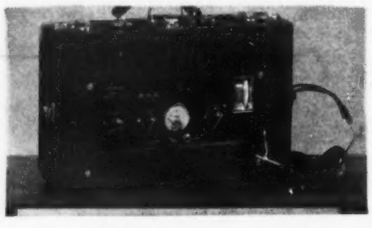
Trouble Finder for Power Companies

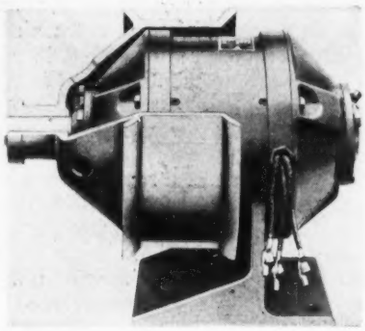
A NEW RADIO INTERFERENCE trouble finder for use by power companies has been added to its line of such equipment by Hallock-Watson & Yonge, 191 Park Street, Portland, Ore. The latest set is the "Trouble Finder-6," illustrated. Its dimensions are 5½x10½x



17 in. and it weighs 23 lb. complete. The instrument consists of a loop-operated radio receiver calibrated for audibility measurements by headphones or separate audibility meter. A more elaborate eight-tube model also is made which incorporates a loud speaker and visual volume indicator.

Special Motors for Run-out Tables

SPECIAL MOTORS, designated type M, for run-out tables in steel and tube mills and for other conveyor work, have been developed by the Reliance Electric & Engineering Company, Cleveland, Ohio. They are each provided with a single heavy welded-steel support, so located that a pulley type roller keyed to the motor shaft can rotate around the body of the motor. Various shaped rollers



to suit the material to be conveyed can be used. The motors with rollers are lined up in tandem, the distance between being governed by the material conveyed.

An installation may require any number of units, depending on the distance of travel and the roller spacing. If a motor should fail, it will act as an idler roll and will not hold up production. Least possible maintenance is required, since there are no external gears, chains, pulleys or tests demanding attention. Periodic lubrication of the motor bearings is all that is necessary. The only bearings are those for the motors, and they are anti-friction, offering little resistance to rotation.

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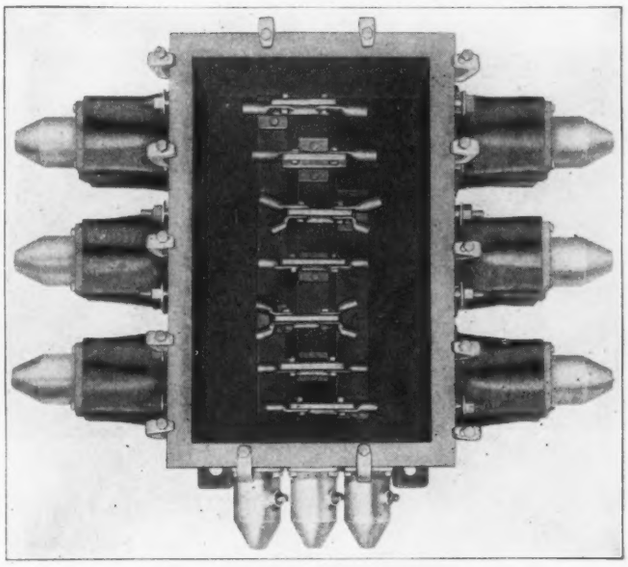
To Change Voltage on Double Commutator

A SIMPLIFIED METHOD OF CHANGING the voltage on the double commutator type Columbia electroplating generator has been announced by the Columbia Electric Manufacturing Company, Cleveland, Ohio. Quite frequently a user will order a 6-volt, double-commutator type, compound-wound, self-excited electroplating generator and later on decide that a 6/12-volt machine will be required, or vice versa. The Columbia generator provides for this by equipping this type of machine with external connections that can be changed easily by taking off four nuts. This gives the advantages of two machines in one. The same generator can be used for both still tank plating and barrel plating.

G & W Type "G" Boxes
may be just what you want



Type "G", 600 Volts, Seven Way

Small size, low-cost boxes affording flexibility and convenient control of customer's taps.

No Links or Fuses

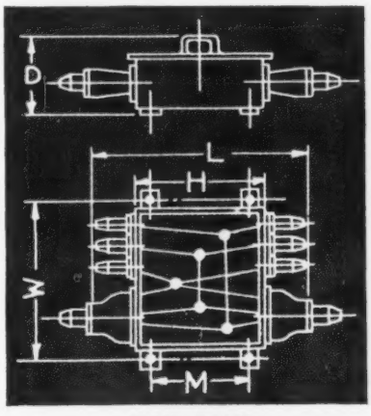
Conductor terminal lugs are bolted directly to busbar contact fittings.

Standardized boxes for any number of circuits or any size of conductor.

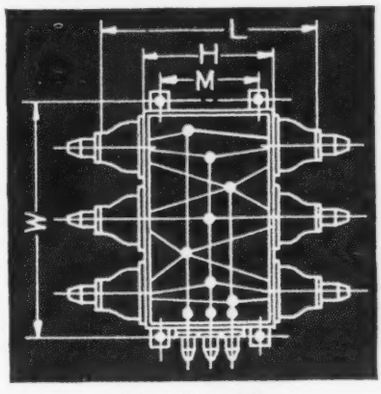
600 Volts

Catalog No. 30—Bulletin "G" contains data on many types of boxes.

Send for quotations and further data.



FOUR WAY



SEVEN WAY

The air gauge tells you that G&W Boxes are Air Tight

G & W Boxes are air tested before leaving the factory and provided with air valves that you may make your own tests from time to time.

Potheads · Subway Boxes · Cable Terminal Devices · Automatic Transfer Switches

G&W Electric Specialty Co.

7780 Dante Avenue, Chicago · · · · Representatives in Principal Cities

Specifications—

(Catalog)
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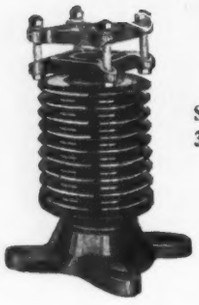

Sec.
3200

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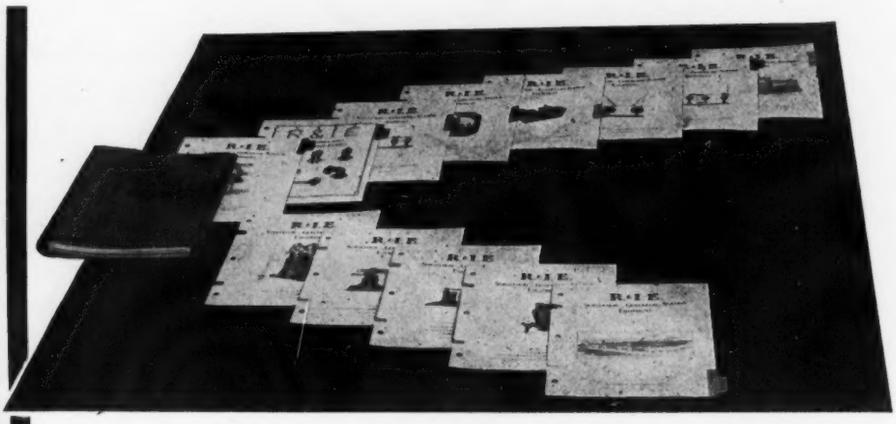
1330



—have no terror to the engineer or operator when selecting reliable switching equipment from the complete ready-reference R. & I. E. loose leaf catalog. You are still looking for reduction of maintenance costs on switching equipment. Here is the simple way to find it. Write for your copy.

RAILWAY AND INDUSTRIAL ENGINEERING CO., GREENSBURG, PA.

Representatives in

Boston	Buffalo	St. Louis	Indianapolis	San Francisco
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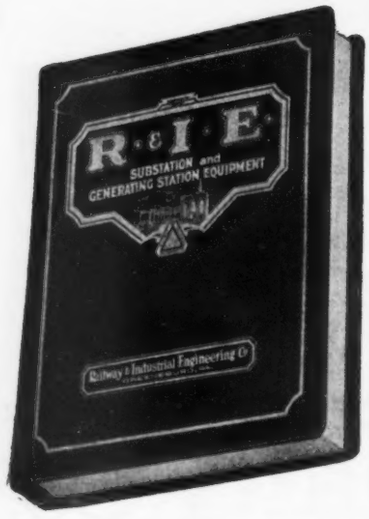

Bus Supports
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Disconnecting Switches
Air-break Switches
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Motor Mechanisms
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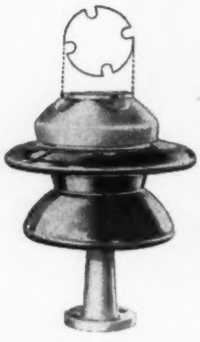

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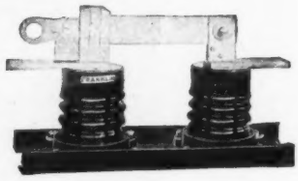

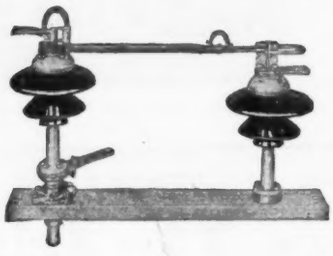

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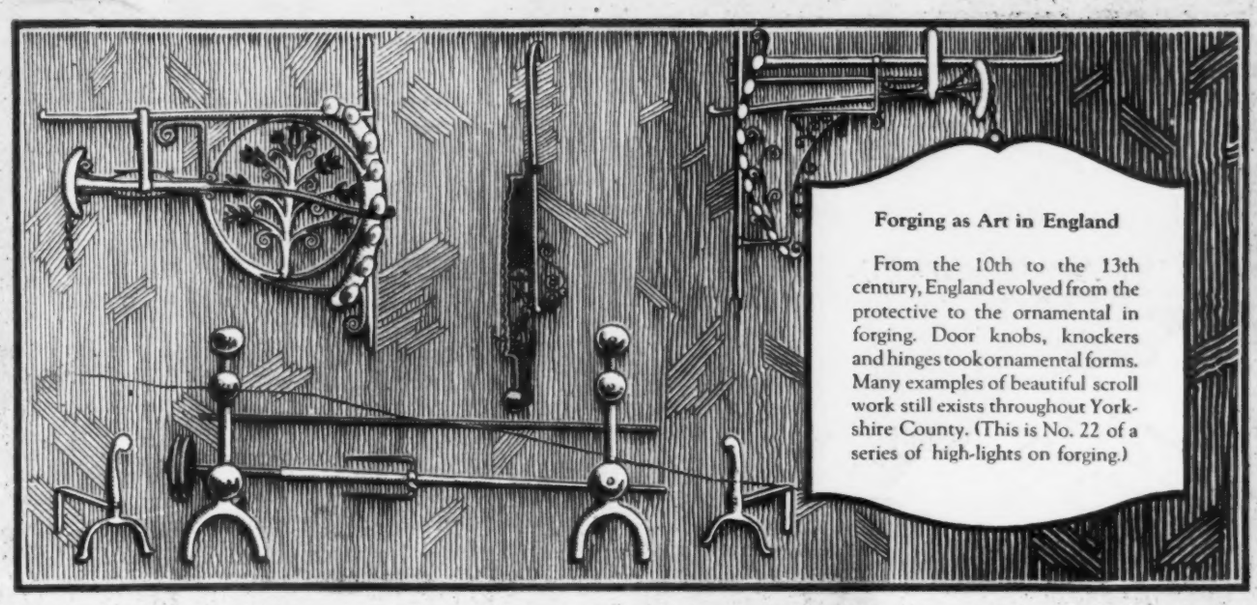
Twenty years of successfully serving the Producers and Users of Electric Power

Present Day
Standards Demand
Drop Forgings



Forging as Art in England

From the 10th to the 13th century, England evolved from the protective to the ornamental in forging. Door knobs, knockers and hinges took ornamental forms. Many examples of beautiful scroll work still exists throughout Yorkshire County. (This is No. 22 of a series of high-lights on forging.)

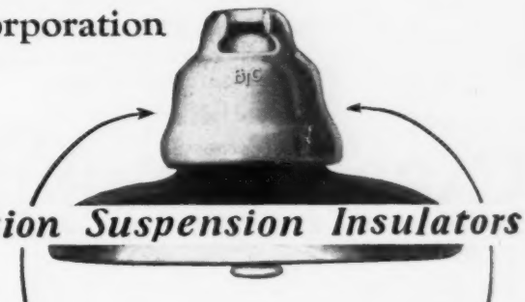
Beauty Gone—Service Remains

ONE cannot talk of the beauty of present day commercial forgings, for their's is to fulfill a different purpose. It is service that counts in supplying hardware for high tension suspension lines, and when service is needed, look to a BTC drop forging. Immense hammers dropping with terrific force pound out a strong uniform and accurate product. When the engineer specifies BTC drop forged hardware he is assured of economical maintenance for BTC hardware is drop forged from 1035 copper-bearing steel to resist corrosion. This together with the machined accuracy, the superior strength and uniformity of the metal offers the engineer hardware that will give service. Specify BTC drop forged hardware.

Why a Drop Forged Cap?

1. They are uniform in quality
2. They are superior in strength
3. They are made of anti-corrosive steel
4. They are uniform in dimensions
5. They can be heat treated to give maximum strength with minimum weight
6. They have precision milled joints and drilled holes
7. They allow a smooth, even porcelain seat
8. They are free from hidden defects and concealed flaws

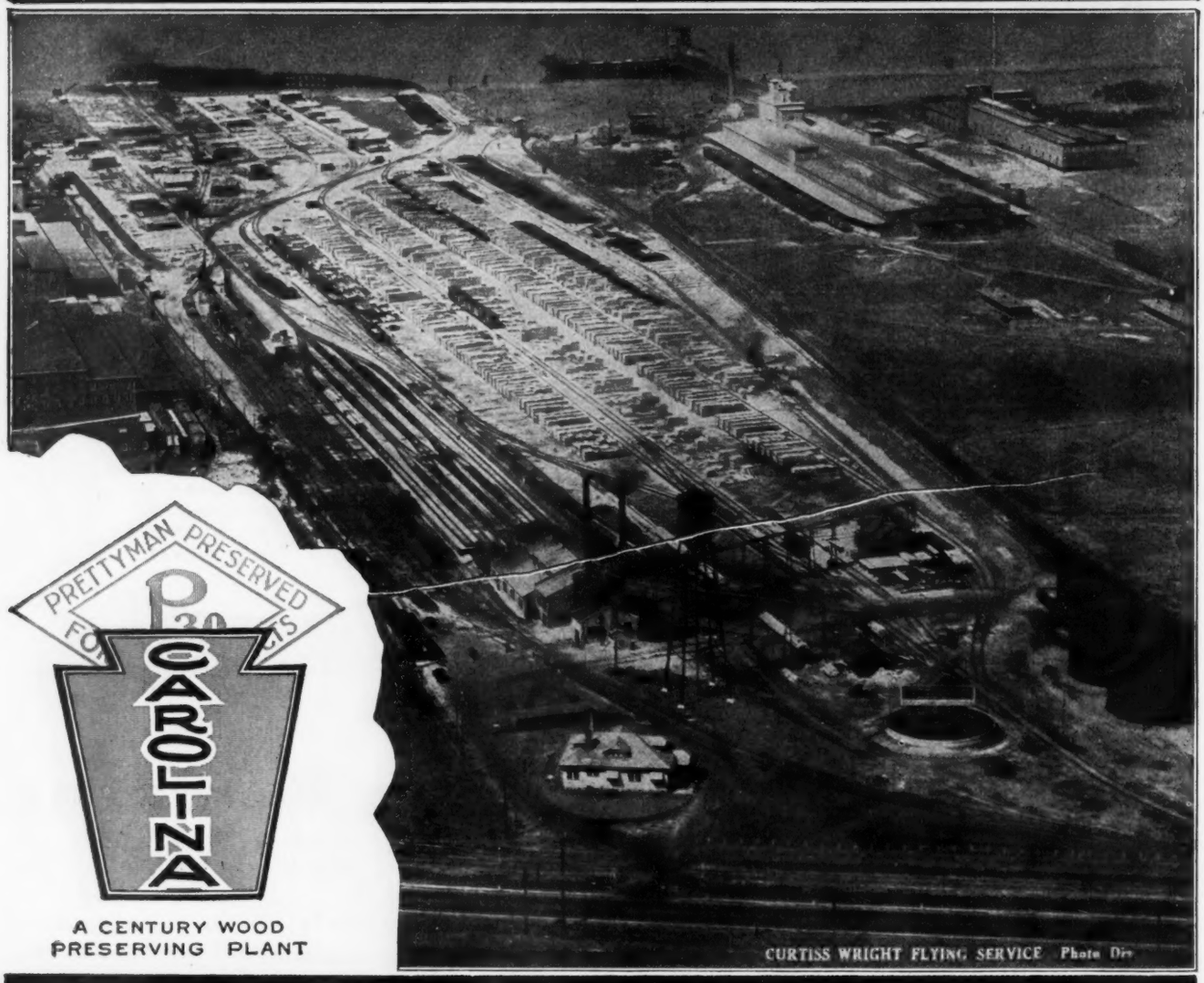
The Brewer-Titchener Corporation
Cortland, New York



For High Tension Suspension Insulators

Specify BTC Drop Forged Caps

Prettyman becomes CAROLINA



. . . and the Diamond, a KEYSTONE

Known for three years of meritorious service to industry, the complete and modern wood preserving plant of J. F. Prettyman & Sons now has joined the distinguished Century group.

It was purchased May 15 by the Carolina Wood Preserving Company, headed by Grant B. Shipley of Pittsburgh, president of the Century Wood Preserving Company and associated companies operating Century plants.

Century policy holds out to you the same high standards of quality and service which have been associated with the name of Prettyman, *plus* the rich background of achievement, experience and engineering research which have made the Shipley organization leaders in their field, *plus* the combined resources and facilities of seven strategically located plants in the Century chain.

Write today for prices.

CAROLINA WOOD PRESERVING COMPANY

FORMERLY

J. F. Prettyman & Sons
Wood Preserving Plant

CHARLESTON, SOUTH CAROLINA

Standards TODAY That Give Reliability to the Suspension Insulator

THE ONE-PIECE SUSPENSION UNIT

▼

THE BALL AND SOCKET JOINT

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THE GASKET ASSEMBLY

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THE SANDED SURFACE JOINT

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THE TREATED SANDED SURFACE

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O-B

DEVELOPMENTS HAVE CONTRIBUTED IMMEASURABLY TO THE RELIABILITY OF ALL CAP-AND-PIN TYPE SUSPENSION INSULATORS . . RELIABILITY WHICH IS A VITAL NECESSITY TO THE SOUND GROWTH OF ELECTRICAL TRANSMISSION

OHIO BRASS COMPANY, MANSFIELD, OHIO
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Ohio Brass Co.

NEW YORK PHILADELPHIA PITTSBURGH BOSTON CHICAGO CLEVELAND LOS ANGELES ST. LOUIS SAN FRANCISCO ATLANTA SEATTLE DALLAS

PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
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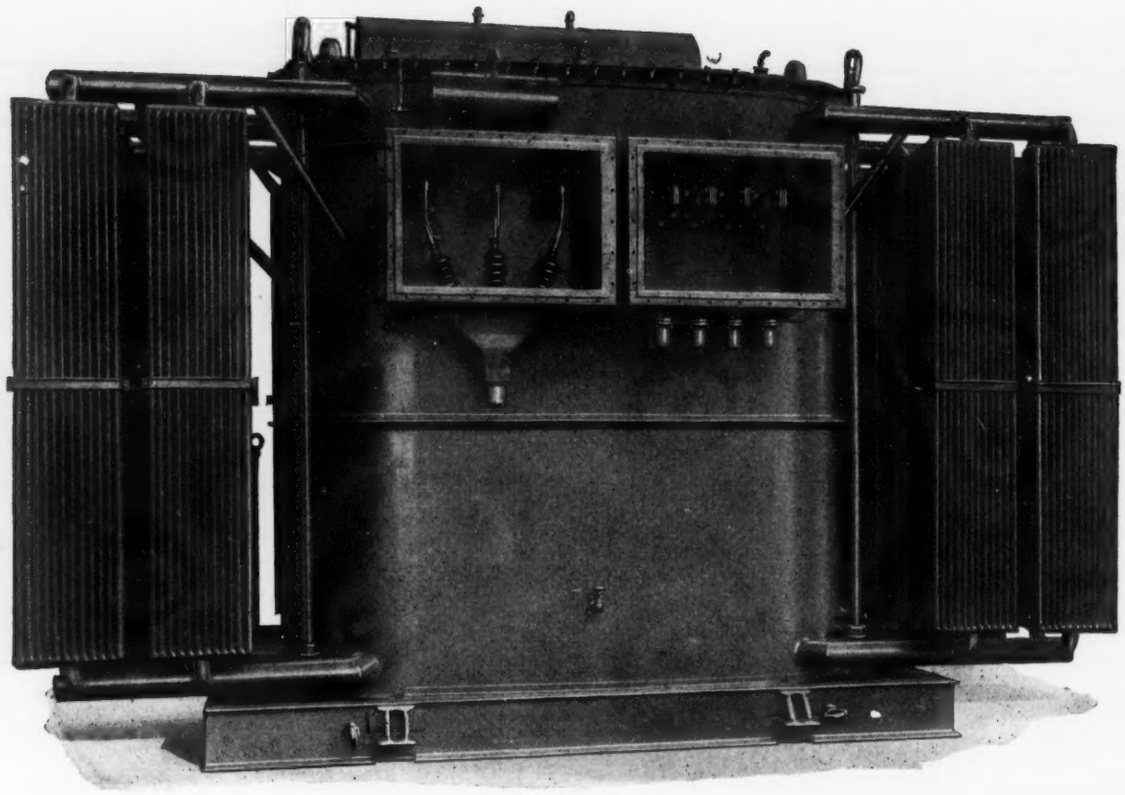
VALVES



On the lines of the Edison Electric Illuminating Co.

. . . . This 5000/7500 kva., 3 phase 13,800 - 2400/4150Y volt transformer built for the Edison Electric Illuminating Company, of Boston, has in addition to the usual features of Allis-Chalmers transformers:-

Film type radiators connected to improved equalized oil flow manifolds. . . . High and low voltage pothead compartments — removable without disconnecting line cables. . . . Auxiliary expansion tank for use with high voltage pothead chamber. . . .

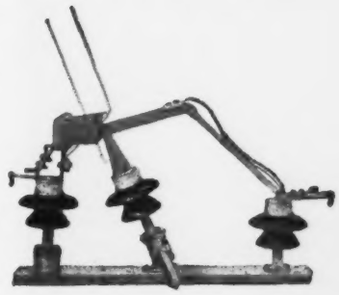
And it was shipped filled with oil and ready for service.

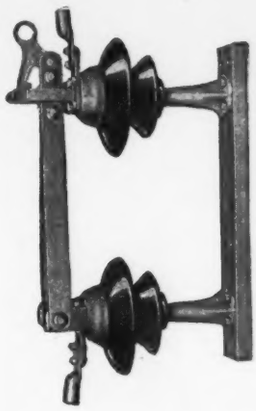
Allis-Chalmers electrical equipment includes machinery for the generation, transformation, conversion, and utilization of electric power.

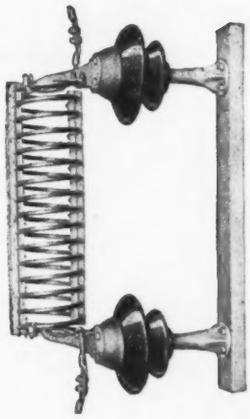
ALLIS-CHALMERS

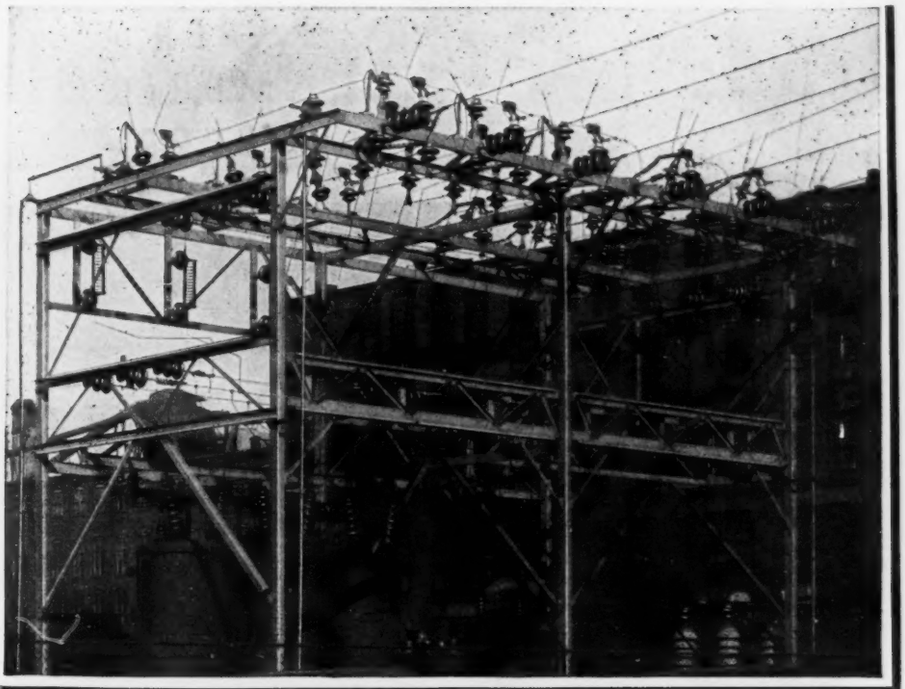
Allis-Chalmers Manufacturing Company, Milwaukee

* SERVICE VALUE









Excellence in Engineering, Designing and Manufacturing

Engineering, Designing, Manufacturing—each a specialized branch with one dependent upon the other for successful high tension line and station equipment.

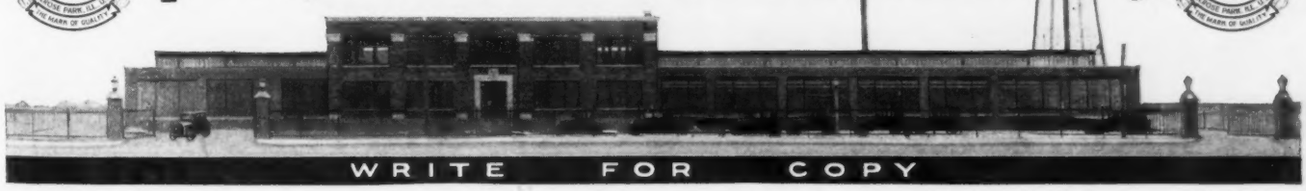
Proper coordination of these three factors is found at the "Three E" factory. It is the reason why "Three E" Equipment has been of constant aid to the electrical industry in its betterment and expansion program.

The "Three E" Organization is interested in any operating problems you may have. The flexibility of "Three E" Equipment can economically answer them.

* "Service Value" = Low cost per year of service

ELECTRICAL ENGINEERS EQUIPMENT CO.
General Offices and Factory: MELROSE PARK, ILL.
Chicago Office: 205 W. Wacker Drive
Eastern Office: 21 Park Row, New York
Sales Offices in all principal cities
Canadian Representative: Northern Electric Company LIMITED

It Pays to use the "Three E" catalog



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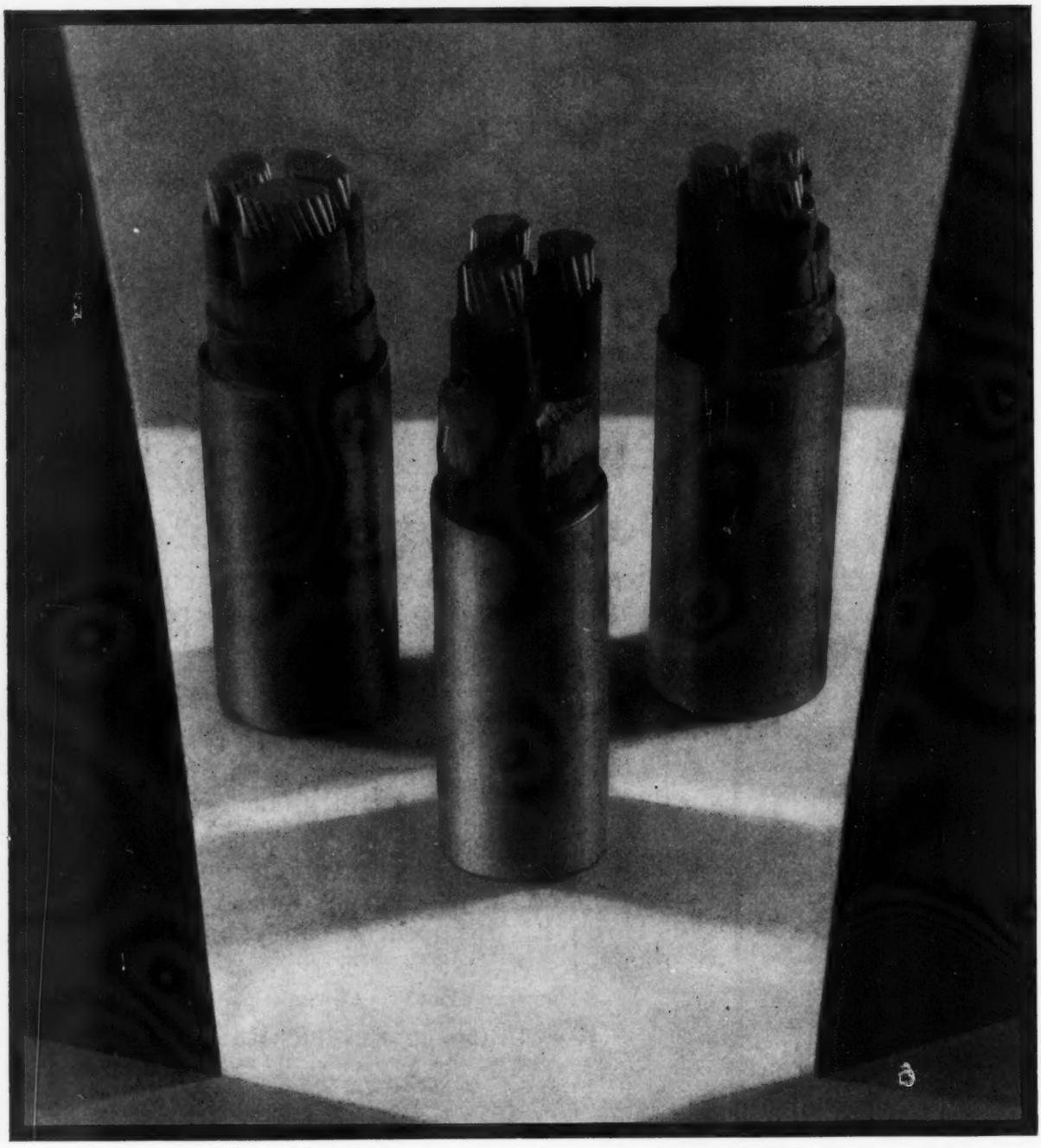
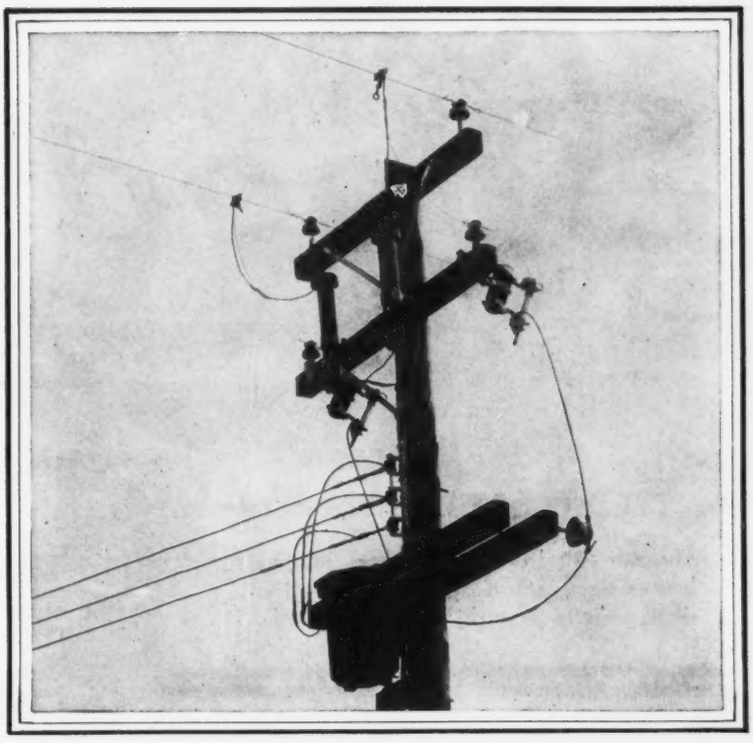


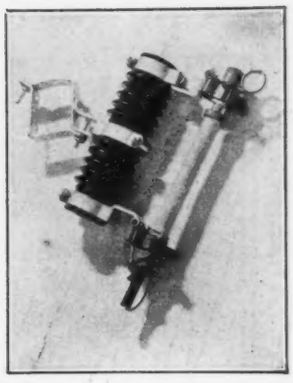
For heavily congested or outlying districts—transmission or distribution circuits—there is a Safety Power Cable with the right insulation for any specific electrical need.

GENERAL CABLE CORPORATION

EXECUTIVE OFFICES: 420 LEXINGTON AVENUE, NEW YORK · OFFICES IN PRINCIPAL CITIES

Single-Insulator Fuse-Switches





Interchangeability—A Desirable Feature

KEARNEY Single-Insulator Fuse-Switches were designed primarily as an inexpensive switch which would help justify the construction of rural line projects where the net return is doubtful. They are equally well adapted to use on other than rural line construction because they incorporate the same reliable features which makes the Kearney Standard Two-Insulator Fuse-Switch so desirable. As in all other Kearney Switches, the insulators are made of plastic wet process porcelain, identical in material and in methods of manufacture with high potential insulators. Thus the porcelain used in Kearney Switches equals the porcelain in line insulators both in electrical and mechanical characteristics.

The hanger of these switches will accommodate any standard size crossarm. Where construction costs demand economy, stamped contacts can be substituted for the full-floating contacts at a considerable saving.

Other Kearney Products

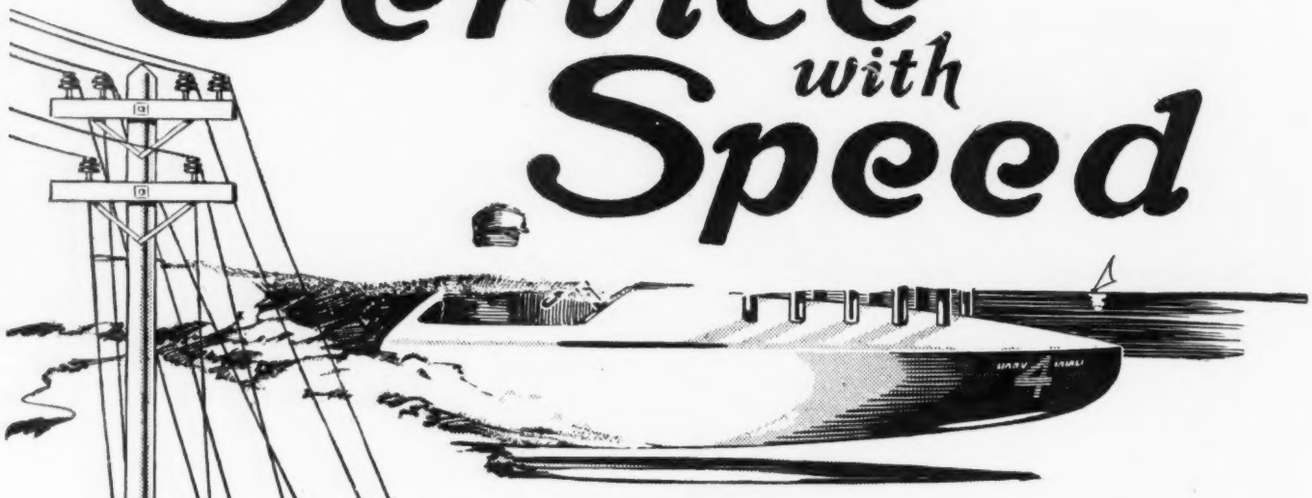
Screw Type and Expansion Type Anchors, all made of certified malleable iron, guaranteed against breakage; Solderless Wire Connectors; Guy Wire Clips; Double Duty Fuse and Disconnect Cutouts; Sectionalizing Disconnects; Fuse Pullers; Cable Clamps; Live Line Tap-Off Clamps; Grounding Sets; Live Line Tools and Accessories.

JAMES R. KEARNEY CORPORATION
MAIN OFFICE
4224-40 Clayton Ave. • • • • • St. Louis, Mo.
Factories: St. Louis, Mo. • • Taylorville, Ill. • • Toronto, Canada

KEARNEY

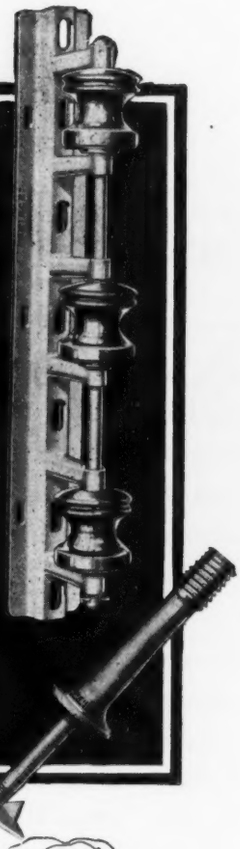
THE- ELECTRICAL-INDUSTRY'S-PRODUCTS

Service with Speed



Through 172 Leading Electrical Jobbers located throughout the United States, all of whom carry large stocks . » » » » »

APPRECIATION of the Achievement of those Vast Legions in Humble and Exalted Positions who in a Few Short Years have made the Electrical Industry the World's Outstanding One, and GRATITUDE for the Small Part we have been permitted to play.



THE HARDWARE makes the Line

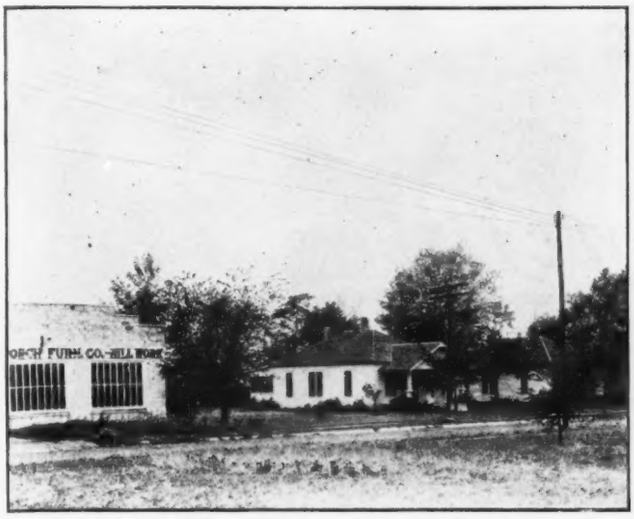
Hubbard makes THE HARDWARE

3 large plants

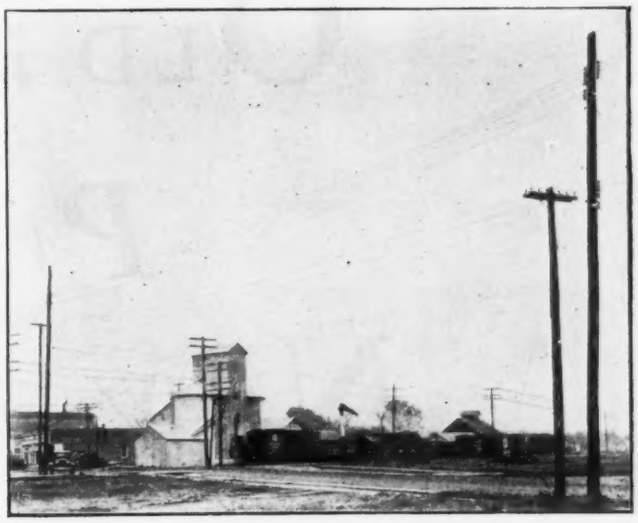
Hubbard and COMPANY

PITTSBURGH • OAKLAND, CAL. • CHICAGO

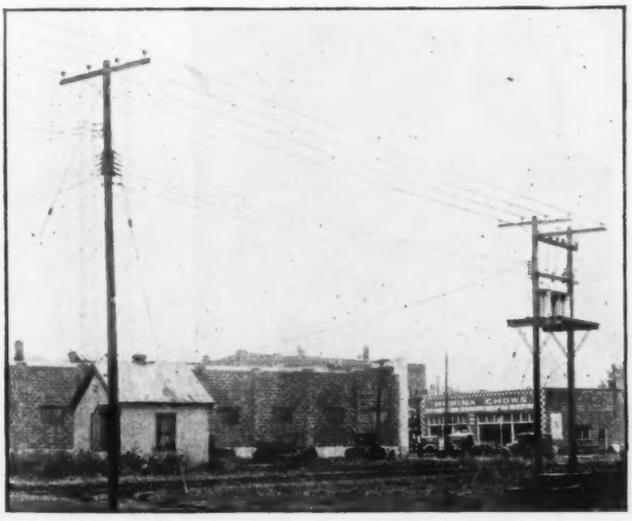
STUDY THE PICTURES OF THIS INSTALLATION OF NO. 6 A.C.S.R.



Residential distribution secondaries in Richmond, Kansas. Note the flatness and evenness of sag after twelve years service with no repair.



Railroad crossing span, Richmond, Kansas, distribution system. This 175′ span was installed twelve years ago and has never been resagged. Note the evenness of the sag.



Distribution system in town of Richmond, Kansas, showing bare A.C.S.R. primaries and A.C.S.R.—T.B.W.P. secondaries. This installation is twelve years old. The secondaries have never required resagging. And the weatherproofing is still intact.

A. C. S. R.
—T. B. W. P.
Aluminum Cable
Steel Reinforced
—Triple Braid
Weatherproof

Serving 17 towns—up 12 years and "slack" has never appeared

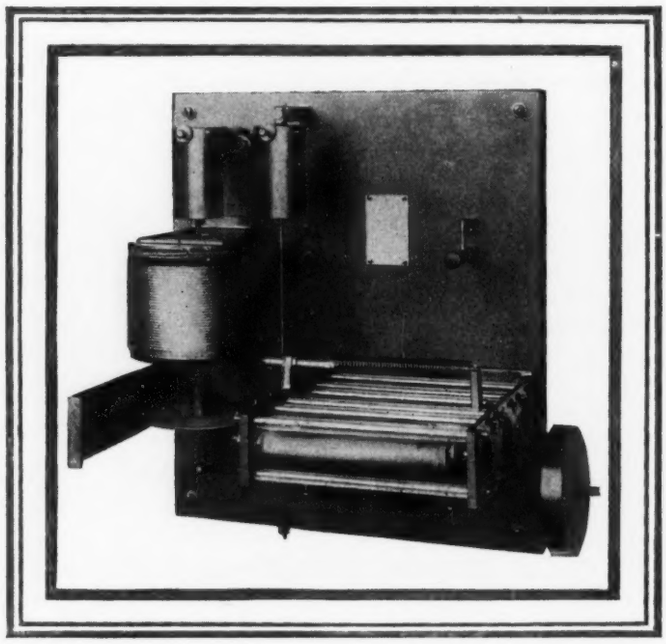
No wonder Mr. I. C. Bushong, President and General Manager of The Municipal Power Transmission Company, of Ottawa, Kansas, is enthusiastic about A. C. S. R.—T. B. W. P.

This insulated cable has 6 aluminum strands over 1 steel strand. Its insulation stands up better than that on any other equivalent metal cable because, for a given conductivity, A.C.S.R. has a larger cross section and operates at a lower temperature.

Let us send you information about A.C.S.R.—T.B.W.P. for distribution systems, also data on bare A.C.S.R. for transmission service. Our nearest office will gladly send a representative to talk with you. ALUMINUM COMPANY *of* AMERICA; 2438 Oliver Building, PITTSBURGH, PENNSYLVANIA.

ALCOA ALUMINUM

OLD *in*
Principle
NEW in Design



Type AP-23 a-c. carbon-pile type voltage regulator (cover removed)

BASED upon the established principle that the resistance of a stack of carbon discs varies inversely as the pressure between them, Westinghouse recently designed the Carbon-pile Type Voltage Regulator for a-c. and d-c. generators.

This new regulator is extremely sensitive, has a high degree of accuracy in voltage regulation, and is quick-acting in restoring the voltage to normal. Means for anti-hunting are provided mechanically.

Furthermore, this type of regulator is particularly economical for the operation of small units. It requires practically no maintenance, because of the absence of contacts and the simplicity of both the lever system and the air dash-pots.

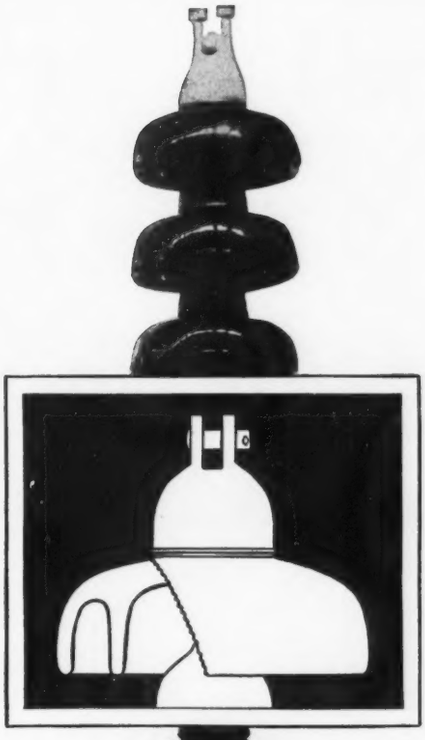
For complete information, call or write our nearest office.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

T 31310

TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY EVENING.



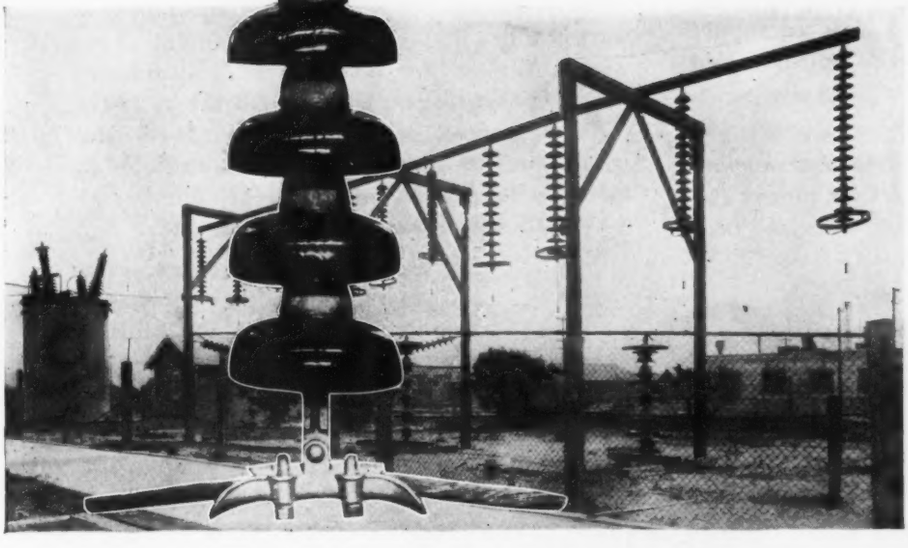
TESTED
in Spray and Fog

Tests have shown that insulators best adapted for fog service should have:

1 **A shape that provides resistance to surface leakage.**

2 **A shape that can be easily cleaned.**

Westinghouse, cooperating with Western power company engineers, has met these requirements in the Westinghouse Fog-Type Suspension Insulator. This unit is so designed that it holds strength in reserve, in addition to providing those features essential to satisfactory performance in salt-fog areas.



Redondo Beach test of Southern California Edison Company conducted for more than two years with 150,000 volts on the bus.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

W WESTINGHOUSE ELECTRIC

T 31236

TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY AT 10:00 P. M., E. S. T.

GOLD!

and the Colt cracked night and day

"Thar's gold in them hills." From St. Louis, Fort Leavenworth, Fort Laramie and Santa Fe, streamed the wagon trains. Along the trails the painted savage barred the way. From the forts along the route went forth the hunters, armed with rifle and Colt, to supply buffalo and deer meat for the soldiers and adventurers seeking the glint of yellow.

Rations were won by the Colt and the war-cry of the savage was stilled by the same weapon. Clear West to California the Colt blazed the way, protecting the seekers en route and protecting their claims when struck.

Today in the electrical industry, men are seeking to protect electrical equipment. Again Colt enters the picture, arming these men in industry with the colt-made NOARK line of service and meter protection devices. Thus is Colt upholding the tradition that its products must protect and make secure. Geared to the task are men and equipment of rare calibre in achieving mechanical precision. Watch-like methods of manufacture have, for seven years, fashioned the NOARK line according to Colt standards—a line chosen out of hundreds offered because of its peculiar mechanical nature—for Colt has always worked towards mechanical ends.

When discussing the protection of electrical equipment, remember that NOARK is now built by Colt; that NOARK protection is now Colt protection as well.

COLT
NOARK

COLT'S PATENT FIRE ARMS MFG. CO., Established 1836

Electrical Division, HARTFORD, CONN., U.S.A.
Electrical Division 1886

NOARK SERVICE BOXES HOLD UP UNDER CONSTANT SERVICE

Indoors or outdoors—overhead or underground — wherever there is moisture, dust, lint or fumes . . . . Cast iron—watertight—full line of entrance hoods and conduit fittings —fuse pulling mechanism in cover

—exceptionally compact in size and . . . . A COLT PRODUCT . . . . Send for catalog A and detailed, description. "The Rampant Colt," an interesting publication, mailed on request.

M-1

Here is the NEW Roto-Test Switch

FACE PLATE MOUNTED ON SWITCHBOARD

It has entirely revolutionized Meter and Relay Testing

Make connections to testing studs—turn the handle of the Roto-Test Switch—and you are ready to test any instrument. Quick—easy—safe. Over Current Relays may be tested one phase at a time, holding partial protection. The test period may be confined to 10 seconds. Cannot be operated without key.

Unparalleled Efficiency and Safety

The Roto-Test Switch is mounted on the back of the board. Only the face plate appears on the front. Neat—saves space—safe. The operator does not have to go back of the board or make any hot connections.

Moreover, the Operating Handle will not come out until circuits are restored to normal operating position. Hence, wrong connections or errors in reconnections are impossible. Men, instruments and circuits are protected. Switch is so arranged that the current transformer circuit is never opened. No trip circuits are left open—practically accident proof. Four, six, eight, and ten pole types.

Greater Economy of Space and Time

A great saving in space is realized by use of the Roto-Test Switch as it requires but a 4-in. x 4-in. space on switchboard. It can be applied to any type of switchboard for use with any standard make of instruments, meters or relays.

A heavy, durable, Bakelite case encloses all parts. Access for inspection being had through removable top and bottom covers.

Special designed phosphor bronze clips, switch members and full floating rotor compose the operating assembling of the most compact device of its kind.

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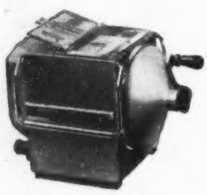
This test is made by *direct-current* and the instruments read *directly* in ohms and megohms.

High-Range "MEGGER" Testing Set

Built in various ranges up to 40,000 megohms, with hand generators rated from 150 volts up to 2500 volts d.c. *Constant-pressure.*



"Meg" and "Super-Meg" Insulation Testers

Various ranges up to 100 megohms; with hand generators rated from 100 volts up to 500 volts. Weigh 6¾ and 7¼ lb. respectively.

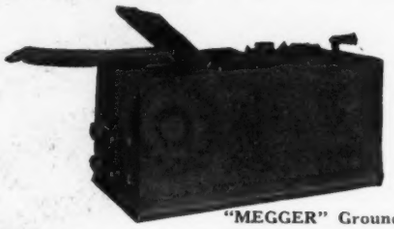
New "Bridge-Meg" Resistance Tester

Combines the constant-pressure, 500-volt "Super-Meg" (range 0 to 100 megohms) with a Wheatstone Bridge (range .01 ohm to 999,900 ohms). Weighs 12¾ lb. A universal resistance testing set "under one roof."

The complete "Megger" family includes a wide assortment of ranges which meet every practical requirement for quick tests of insulation resistance up to 10,000 megohms. For full particulars, please ask for Catalog 1205-W.

2. FOR TESTING THE RESISTANCE TO EARTH OF GROUND CONNECTIONS

This test is made by *alternating-current* and the instruments read directly in ohms down to as low as 3 ohms full scale.



"MEGGER" Ground Tester

TESTING ground connections—formerly a complicated and time-consuming task—is reduced to a single operation by this "Megger" instrument.

Instead of making a number of voltmeter and ammeter measurements and *calculating* the final result, *one man* can test ground connections with the "Megger" Ground Tester merely by making connections and turning the crank. *The result is shown by the direct deflection of a pointer over a scale—like a voltmeter.* Two auxiliary ground electrodes are used, except where connections can be made to a city water system. The "Megger" Ground Tester has its own self-contained source of current—no batteries; it is wide in range and free from the effects of stray current in the earth. Grounding surveys are being made with it at surprisingly low cost.

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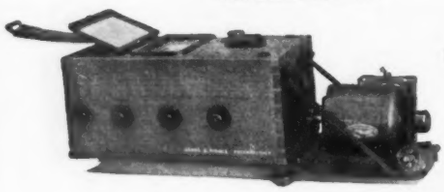
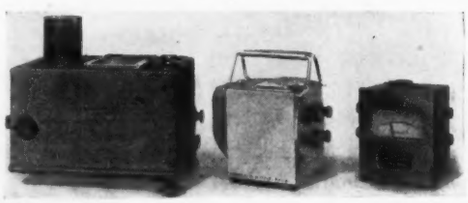
3. FOR FACTORY PRODUCTION RESISTANCE TESTS

Motor-driven "Megger" Testing Sets and "Megger" and "Meg" direct-reading Ohmmeters are designed for continuous hard service in factory production and other routine testing. They include all ranges from as low as .01 ohm full scale up to 10,000 megohms. Motor-driven sets operate from a. c. or d. c. lighting circuits, and direct-reading Ohmmeters from an external source of direct-current. Write for descriptive Bulletin 1200-W.



A motor-driven, high-range "Megger" Testing Set.



"Megger" and "Meg" direct-reading Ohmmeters.

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These millions of feet are installed in both conduit and open.

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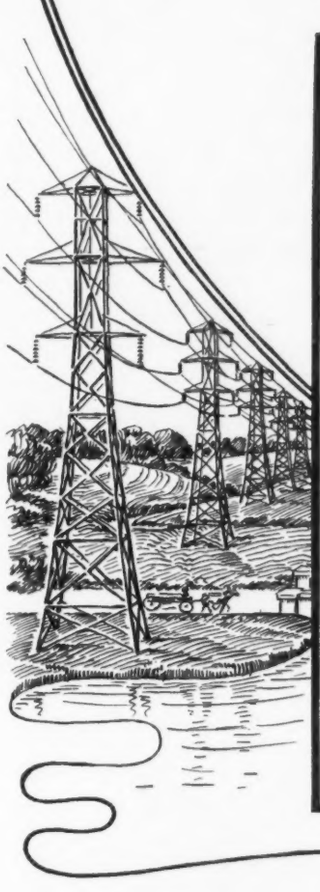

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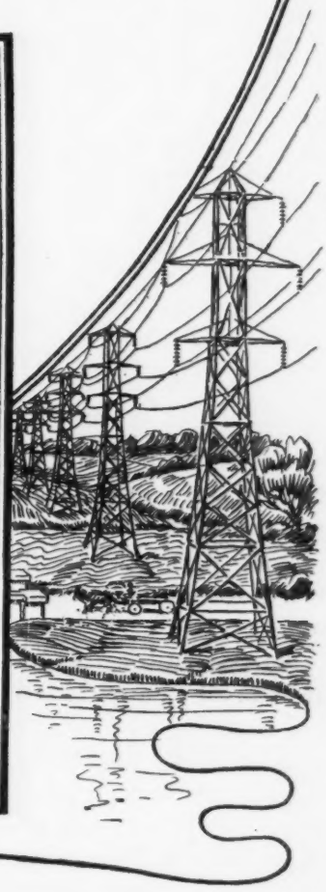
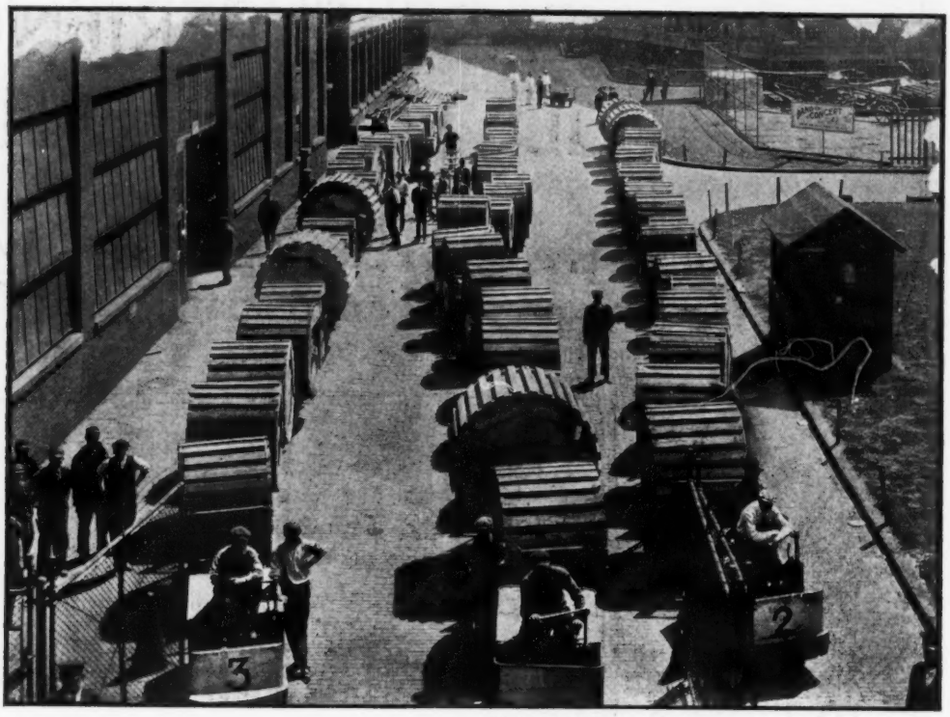


THE KELSO-WAGNER COMPANY---- DAYTON, OHIO

Here's how one company SAVES on its Material Handling



9 MILLION POUNDS of material moved daily with Exide-Ironclad-equipped industrial trucks and tractors.

A PROMINENT manufacturer handles all material with Exide-Ironclad-equipped industrial trucks and tractors. A booklet of the Industrial Truck Association reports that as a result nearly $2,000 a day is saved.

Forty-seven lift trucks and eighteen tractors, all equipped with Exide-Ironclad Batteries keep *nine million* pounds of material moving daily.

Any company, large or small, can make savings proportionally as great. Exide-Ironclad-equipped industrial trucks and tractors save time and dollars . . . keep a steady flow of stock in transit . . . move five times the load at three times the speed . . . release labor for more productive work.

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Write for Bulletin 160-R. It gives information about Exide-Ironclad-equipped industrial trucks and tractors, and shows how they cut material-handling costs . . . speed production in many varied industries. No obligation.

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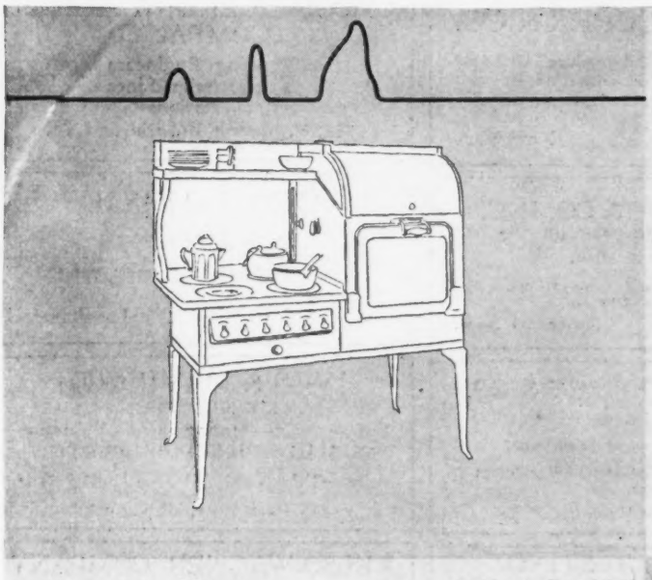
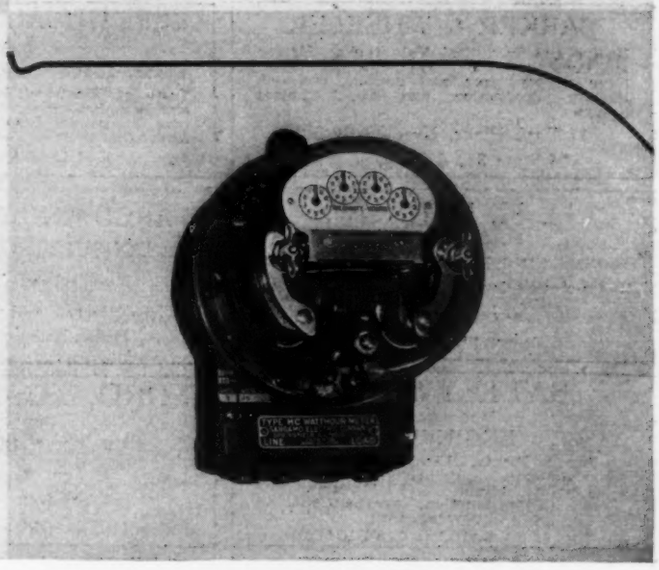
How do ranges
AFFECT YOUR METER INSTALLATION?



WHEN the range comes along with its 5 kw used 0.8 hours per day and its 1 kw used 4 hours per day, a meter decision must be made. If old meters are used, the choice is between an oversize meter that gets all the peak income, or an average size meter that loses part of the peak. A Sangamo HC Meter for the average load gets all the income from light load to 300 per cent load.

THE SANGAMO HC is the more-load-per-consumer meter. The H C is the correct meter when loads are increasing . . . when peaks are frequent . . . when power-factor is low. While loads are building, the HC will measure the peaks and thus, without loss of revenue, bridge the gap to the final load which will require a larger meter.



Sangamo Type HC Meter is for modern load building. It has a straight-line accuracy from the lightest up to 300 per cent. load and is temperature compensated from 20 to 120 deg. F. at all power-factors. It is not appreciably affected by variations in voltage or frequency. Bulletin 79 tells all about the HC Meter. Write for it.

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3—2,000 Kva. Gen. Elec., 48,000 v. prim., 24,000 v. sec.
6—1,667 Kva. Gen. Elec., Type H, 66,000 v. prim., 11,000 v. sec.
3—1,667 Kva. Gen. Elec., Type H, 22,000 v. prim., 11,000 v. sec.
1—1,500 Kva. Gen. Elec., 3 ph., 6,600 v. prim., 220-110 v. sec.
1—750 Kva. Pittsburgh Furnaces Transformer 25,000 - 12,500 v. prim. to 280-260 - 240 - 220 - 200 - 140 - 130 - 120 - 110 - 100 v. sec.
3—400 Kva. Pittsburgh, 13,800 v. prim., 2,300 v. sec.
3—350 Kva. Gen. Elec., 6,600 v. prim., 460 v. sec.
3—333 Kva. Pittsburgh, 22,000 v. prim., 460 v. sec.
3—333 Kva. Allis-Chal., 2,300 v. prim., 460 v. sec.
1—300 Kva. Westg. Auto Transformer consisting of 2 single phase Transformers, 60 cy., 488 v., 3-wire, 3 ph., 60, 440 v., 3-wire, 2 ph. (can be reconnected to 220 v., 3-wire, 3 ph. to 220 v., 4-wire, 2 ph.).
3—250 Kva. Westgh. 22,000 v., prim., 6,600 v. sec.
3—150 Kva. Gen. Elec., Type G, 33,000-13,200 v. prim., 2,400 v. sec.
3—100 Kva. Gen. Elec., Type H, Form RP, 6,600 - 13,200 v. prim., 605-575-545-440 v. sec.
3—100 Kva. Westg. Type SK, 13,800 v., prim., 440/220 v. sec.
3—100 Kva. Westg. 13,200-12,540-11,880 v. prim., 488-244 v. sec.
3—100 Kva. Westg. 2,400 v., prim., 440 v. sec.
3—100 Kva., Pittsburgh, 2,200 v. prim., 2200 v. sec.
3—45 Kva. Gen. Elec. Type H, 22,000 v. prim., 230-460 v. sec.
3—37½ Kva. Gen. Elec., 25 cy., 2,300-2,080 v., prim. 460-230 v. sec.

Archer & Baldwin, Inc.
126 Liberty Street, New York City
Telephone Hitchcock 4545

WANTED
TRANSFORMER
1—Used 50 kv.—4 kva. complete.
Must be in good condition.
W-615 Electrical World
Tenth Ave. at 36th St., New York City

Notice to Advertisers!

Owing to the Holiday July 4th, the *"Searchlight"* pages of the July 5th issue of

ELECTRICAL WORLD

will close one day in advance of the regular schedule. Advertisers will be cooperating with us by sending new advertisements or changes of copy early.

FINAL CLOSING TIME
5 P.M. Monday, June 30th

J. L. HEMPHILL & CO. Inc.

ELECTRICAL ENGINEERS AND EQUIPMENT

801-807 Williams St. North Bergen, N.J.

Telephones: Palisade 2600-2601

MOTOR GENERATOR SETS

1—500 kw., 250 v., Westinghouse Synchronous motor Generator Set.

1—250 kw. 230 v., 3 ph., 60 cy., 2300-4600 v. Synchronous Motor Generator set.

1—200 kw., 230 v., 3 ph., 60 cy , 2300-4100 v Synchronous Motor Generator set.

1—150 kw., 600 r.p.m., 250 v., Gen., 3 ph., 60 cy. 220-440 v., G.E. Synchronous motor.

1—125 kw., 250 v. Westinghouse Synchronous Gen. Motor Set, 3 ph. 60 cy. 230-2200 v.

1—100 kw., 125 v., D.C. 220-440 A.C. G.E. Synchronous Motor Generator Set, 220-440 v.

1—100 kw., 250 v., Gen., 900 r.p.m., 2200 Synchronous Motor.

1—85 kw., 250 v. 1200 r.p.m., 3 ph., 60 cy., 220-440 v., G.E. Synchronous Motor.

1—75 kw., 250 v. Generator, 3 ph., 60 cy., 2200 v., Synchronous Motor.

1—60 kw., 125 v., C.W., 3 ph., 60 cy., 220-440 v. Motor.

1—50 kw., 250 v., Westinghouse 3 ph., 60 cy. 220-440 v.

TURBINES

1—2500 kva., 3600 r.p.m., 2300 volts, 3 phase, 60 cy., Westinghouse and Worthington Condenser 8 years old, good condition.

1—75 kva., 3 ph., 60 cy. Westinghouse Geared Non-Condensing Turbine.

TRANSFORMERS

—1500/3000 kva. G.E. combined oil and water cooled 3 ph., 60 cy., 11000-22000-2300 v.

3—500 kva. G. E. 13000/26000—220/440.

3—500 kva. G. E. 13200—2300.

A.C. GENERATORS

No.	Kw.	R.p.m.	Volts	Ph.	Type
1	1200	600	2300/4100	3	G.E.
1	312	450	440	3	G.E.
1	250	600	440	3	Westg.
2	125	900	2300	3	Cr.-Wh.
3	100	900	230-2300	3	G.E.
1	75	600	220	3	Westg.
1	75	900	2300	3	G.E.
1	50	1200	220-440	3	G.E.
1	50	1200	2300	3	G.E.

MOTORS—3 Phase, 60 Cycle

No.	Hp.	R.p.m.	Volts	Type
1	1500	600	2200/4000	G.E. syn.
1	600	900	440/2200	G.E. slip ring
1	500	900	440-2200	G.E., slip ring
1	350	900	2200/4000	Wh. syn.
2	300	600	445-2300	G.E. syn.
1	250	600	2200/4000	G.E. syn.
1	250	600	220-440	Westg. syn.
1	250	600	440-2200	G.E. syn.
3	200	514	4150-2300	G.E. syn.
4	150	1200	220/440	Westg. sl. rg.
1	150	900	2300	G.E. syn.
2	150	514	2200	Westg. sl. rg.
1	150	1800	2200	Westg. sq. cg. mtr
1	100	900	440-2200	G.E. sq. cg.
1	100	900	220-440-220	Westg. sq. cg.
1	75	600	220	G.E. sq. cg.
1	75	600	220	Fair.-M. sl. rg.
1	75	490	440	Allis-Chal. sl. rg
1	75	900	2200	G.E. Kt.
1	60	1200	220	G.E. sl. rg.
1	60	720	220-440	G.E. Kt.
1	60	300	220-440-230	Fair.-M. syn.
1	50	600	2200	G.E. MT sl. rg.
1	50	900	2200	G. E. B.
1	50	1200	220-440	Wagner sl. rg.
1	40	1700	220-440	Westg. sl. rg.
1	40	1200	220-440	G.E. Kt.
1	25	900	440-2200	Cr.-Wheeler
1	25	1200	440	G. E. K.

(2 Phase Motors on Request)

B. T. S. MOTORS

2—175 hp., 3 phase, 60 cycles, 2300 volts, G. E., Variable Speed, Complete.

BRAND NEW MOTORS

No	Hp.	R.p.m.	Volts	Type
1	40	900	220-440	Gen. Electric KT
1	40	1200	220-440	Gen. Electric MT
1	30	1200	220-440	Gen. Electric KT
1	30	900	220-440	Gen. Electric KT
5	25	900	220-440	Gen. Electric KT
4	25	600	220-440	Gen. Electric KT
1	15	1200	220-440	Gen. Electric KT
2	15	1200	220-440	Gen. Electric MT
1	10	1200	220-440	Gen. Electric MT
5	7½	900	220-440	Gen. Electric MT

D.C. Generators

No.	Kw.	R.p.m.	Volts	Type
1	250	1200	125	Brand new G.E.
1	200	900	250	G.E.
1	200	600	250	G.E.
1	200	525	250	G.E.
2	150	1200	250	Cr.-Wheeler
1	150	600	250	G.E.
2	150	1200	250	Westg., new
1	100	720	250	G.E.
1	75	450	250	Diehl
1	50	600	250	Westg.
1	30	1000	250	Westg.

(Smaller Sizes on Request)

D.C. MOTORS—230 VOLT

No.	Hp.	R.p.m.	Type
1	250	550	G.E.
2	200	1150	Cr.-Wheeler
1	150	600	G.E.
3	150	850	Westg. SK, new
1	150	1100	Westg. SK.
1	125	550	Cr.-Wheeler
1	100	625	Westg. Type S
1	80	500	Allis-Chal.
2	75	475	Westg. Type S
1	50	550	Westg. Sk.
1	50	650	Sprague
1	40	400	Diehl
1	40	1300	Diehl
1	35	200	Diehl
1	35	700	Cr.-Wheeler
1	35	420	Diehl
1	20	665	Diehl
1	20	200	Diehl
1	20	900	Diehl

(Smaller Sizes on Request)

D.C. MOTORS—125 VOLT

No.	Hp.	R.p.m.	Type
1	125	575	G.E.
1	100	600	G.E.
1	80	600	G.E.
3	25	1200	Sprague
1	20	650	G.E.
1	15	775	SK Westg.

FOR SALE

TURBO GENERATOR

Westinghouse, 1250 kva., 2300 volt, 3600 r.p.m., 2 phase, 60 cycle with turbine and condenser. LOCATION—Canton, Ill.

ENGINE GENERATORS

Westinghouse, 2300 volt, 3 phase, 60 cycle with Rice & Sargent and Chuse engines. LOCATION—Mattoon, Ill.

TURBO GENERATOR

General Electric, 2300 volt, 3 phase, 60 cycle with Terry turbine and Worthington condenser. LOCATION—Paris, Ill.

N. C. STIREWALT, *Purchasing Agent*
Central Illinois Public Service Company
Public Service Bldg., Springfield, Ill.

1—**100 hp. General Electric Motor,** Ser. No. 719960, Form K, Type 1-12-100-600, 60 cy., amperes 254, 440 v., speed no load 600, full load 575, with starter. This motor has a double end shaft.

3—**Westinghouse 75 hp. Slip Ring Motors,** 440 v., 3 ph., 60 cy., 855 r.p.m. with starting box and grids. Serial Nos. 1603195, 1603196 and 1603194.

1—**Western Electric Co. 65-kw., D.C. Current Generator** with 75 hp. Allis-Chalmers A.C. Motor with starting box.

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303 Keowee, opp. Valley St., Dayton, O.

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Wanted especially—high voltage large capacity transformers in carload shipments.

HIGH GRADE STANDARD EQUIPMENT

Slip Ring Motors—3 Ph., 60 Cy.

Hp.	Volts	Make	Speed
400	440	Allis-Chal.	450
350	2200-440-220	G.E.	720
225	220-440	G.E.	450
200	2200-440-220	G.E.	600
150	220-440	G.E.	720
150	220-440-550	G.E.	600
100	2200	Westghse.	900
100	440-220	G.E.	720
100	440-220	G.E.	900
75	2200	G.E.	900
75	220-440	G.E.	720
75	440-220	G.E.	900
75	550	G.E.	720
75	550	G.E.	900
50	220-440	G.E.	900
50	220-440	G.E.	1200

Synchronous Motors—3 Ph., 60 Cy.

Hp.	Volts	Make	Speed
325	2200-440	G.E.	200
300	440	G.E.	225
240	2200-440	G.E.	720
135	2200-550	G.E.	900
80	2200-440-220	G.E.	1200

Direct Current Motors

Hp.	Volts	Speed	Make	Type
225	230	635	Westghse.	SK
150	230	575	Westghse.	SK
100	230	1150	G.E.	LC
100	230	625	Westghse.	SK
50	230	850	Westghse.	SK
50	600	1450	Westghse.	SK
35	230	850	Westghse.	SK

Direct Current Generators

Kw.	Volts	Speed	Make	Type
200	250	850	Westghse.	SK
125	250	675	Westghse.	SK
100	250	720	Westghse.	SK
40	250	850	G.E.	RC
35	250	1050	Westghse.	SK

Sq. Cage Motors—3 Ph., 60 Cy.

Hp.	Volts	Make	Speed
300	2200-440	G.E.	514
200	4600-2300	Westghse.	1800
200	2200	Westghse.	600
150	2200	Westghse.	720
150	220-440	Westghse.	600
100	220-440	G.E.	600
100	220-440	G.E.	720
100	2300-4000	G.E.	720
100	220-440	G.E.	1200
100	220-440	G.E.	900
75	220-440	G.E.	900
75	220-440	G.E.	720
75	220-440	G.E.	1200
75	2200	Allis-Chal.	1200

Motor Generator Sets and Rotary Converter

1—200-kw., 250-v., 900-r.p.m., Westghse., SK, connected to 2200-v., 3-ph., 60-cy., syn motor.
1—165-kw., 125-250-v., 6-ph., 60-cy., 1200-r.p.m. G.E. with 2300-4000-v., 3-ph. transformer.
1—100-kw., 250-v., 3-ph., 60-cy., 1200-r.p.m. Westghse., with 2300-v. transformer.
1—90-kw., 250-v., 1200-r.p.m. G.E., R.C., connected to ATI-440-220-v., 3-ph., 60-cy., syn. motor.
1—60-kw., 250-v., 1200-r.p.m. G.E. R.C. connected to KT, 440-220-v., 60-cy. squirrel cage motor.

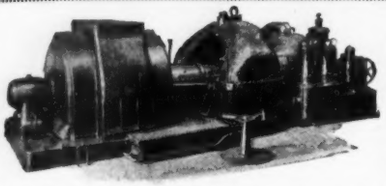
A.C. Generators—3 Ph., 60 Cy.

1—187-kva., 720-r.p.m., 2200-440-220-v. G.E.
1—100-kw., 900-r.p.m., 2200-240-480-v. G.E.
1—75-kw., 1200-r.p.m., 2200-480-240-v. G.E.
1—37 ½-kva., 1200-r.p.m., 2300-480-240-v. G.E

Transformers.

3—Moloney 500-kva., 60-cy., 13200-460 v
3—G.E., 250-kva., 60-cy., 2300-230-460-v.
3—Moloney, 250-kva., 60-cy 33000/16500-2300-v.
3—G.E., 200-kva., 60-cy., 2300-230-460-v.
3—Pgh., 150-kva., 60-cy., 13200-230-115-v.
3—G.E., 100-kva., 60-cy., 2300-230-460-v.
3—G.E., 75-kva., 60-cy., 2300-230-460-v.

STEPHEN HALL & CO., INC., 7th and Adams Sts., HOBOKEN, N. J.



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1—15,000 KW CW-218 Frame—1800 RPM
1—10,000 KVA CW-118 Frame—1800 RPM
1— 7,500 KW CW- 78 Frame—1800 RPM
1— 5,500 KVA CW- 76 Frame—3600 RPM
1— 4,000 KVA CW- 76 Frame—3600 RPM
2— 1,700 KVA CW- 26 Frame—3600 RPM
1— 1,500 KVA CW- 16 Frame—3600 RPM
(3 phase, 60 cycle, standard voltages)

A.S.M.E. CODE DESIGN BOILERS 200-225 lbs.

2—1500 H.P. Cross Drum B & W
2—2650 HP. Ladd Bent Tube
5— 627 HP Stirling Plant, modern stokers, auxiliaries
8— 504 HP B & W Vertical Steel headers, et al.

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POWER PLANT EQUIPMENT

BARGAINS

A.C. Line Regulators

60 Cy., 1 Ph., 2300 V.

1—22 Kva. Westgh. $200
3—16 Kva. Westgh., ea. 125
3—16 Kva. Gen Elec., ea. 125

A.C. Cons. Current Transformers

Gen. Elec., Type "RO"

4—2 Kw. ..... ea. $80
1—3 Kw. 90
4—5 Kw. ..... ea. 100
2—10 Kw. ..... ea. 115
1—25 Kw. 200

Static Condensers

1—150 Kva., Gen. Elec.; 1—200 Kva. G.E.

New Westgh. Syn. Motors

Sizes 125 to 575 Hp.

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A fine 1000 Kw., 3 ph., 60 cy. 3600 r.p.m., 19 stage, G.E. tubine. Very economical.

10—250 hp., 3 ph., 60 cy., 2300 v., 585 r.p.m., Crocker-Wheeler slip ring motors

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Variable Speed—230 Volt—D. C.

1—500-hp. Westgh. Mill, 400/800.
1—75/112-hp. Westgh. SK-180, 425/775.
1—85/100-hp. Westgh. SK-200, 250/550.
1—75/100-hp. Westgh. SK-210, 200/600.
2—25/100-hp. Westgh. SK, 300/1200.
1—75/100-hp. Crocker-Wheeler, CMC-81H, 500/1000.
2—50-hp. Westgh. SK-190, 225/450.
3—35/50-hp. Gen. Elec. RLC, 560/1500.
1—25/30 hp. Electro Dyn., 20s, 400/1200.
1—25-hp. Wetstgh., SK-130, 600/1200.
3—20/25 Gen. Elec. RF-12, 500/1500.
6—15/20-hp. Westgh., SK-110L, 500/1500.
3—10/14-hp. G.E. RLC, 400/1600.
8—10 Westgh. SK, 500/1500.

See last week's listing

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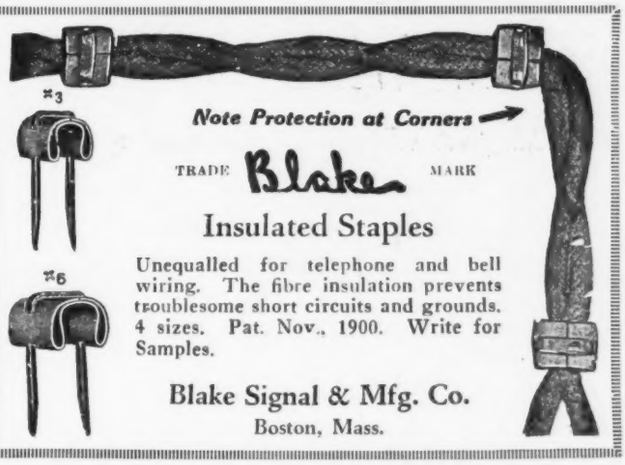

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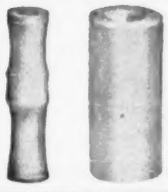

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A Complete Manual of Up-to-date Piping Practice

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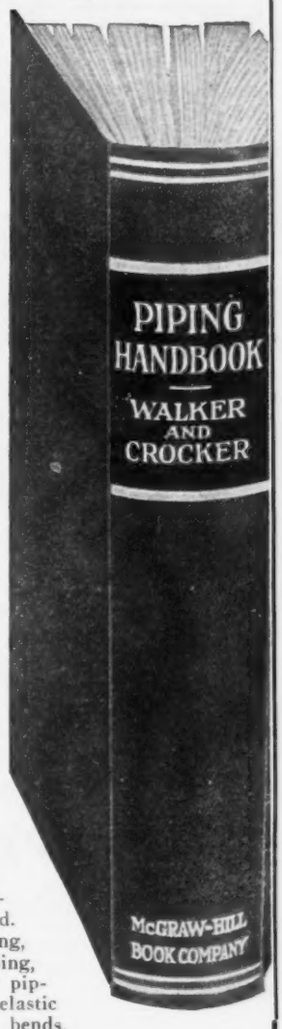

Piping Handbook

by J. H. Walker
Superintendent of Central Heating, the Detroit Edison Company; Member, American Society of Heating and Ventilating Engineers.

and Sabin Crocker
Member, the Detroit Edison Company; Member, American Society of Mechanical Engineers.

with contributions by others.

764 pages, 5x8, 203 illustrations.
204 tables, Flexible Keratol Binding.
Price, $5.00 postpaid

This work covers the field thoroughly, and despite the volume of data and the wide range of subject matter, the latest and most authoritative data is presented in all cases. Fluids, metallurgy of piping materials—every scientific fundamental that influences the design, construction or use of piping systems is included.

The particular problems of steam and power plant piping, heating and plumbing systems, fire protection, oil, gas piping—all industrial applications are discussed and practical methods of solution indicated. Construction details, cost estimating, A.S.A. dimensional standards for piping, A.S.T.M. material specifications for piping, thorough analysis of the elastic properties and straight pipe and bends, handy reference tables in profusion, definitions, charts, formulas—any fact, on any phase of the work is here, in dependable and easily accessible form.

Chapter Headings

1. Definitions, Formulas and Tables.
2. Fluids—Properties of Fluids.
3. Metallurgy of Piping Materials.
4. Pipe, Valves and Fittings.
5. Heat Insulation.
6. Hangers and Supports.
7. Expansion and Flexibility.
8. Steam Power Plant Piping.
9. Building Heating Systems.
10. Plumbing Systems.
11. Underground Steam Piping.
12. Water-supply Piping.
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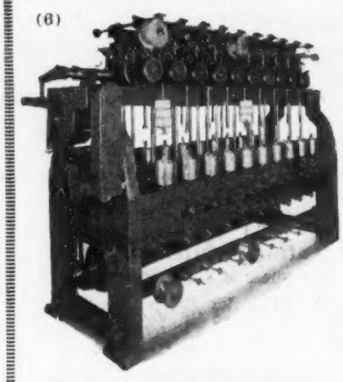

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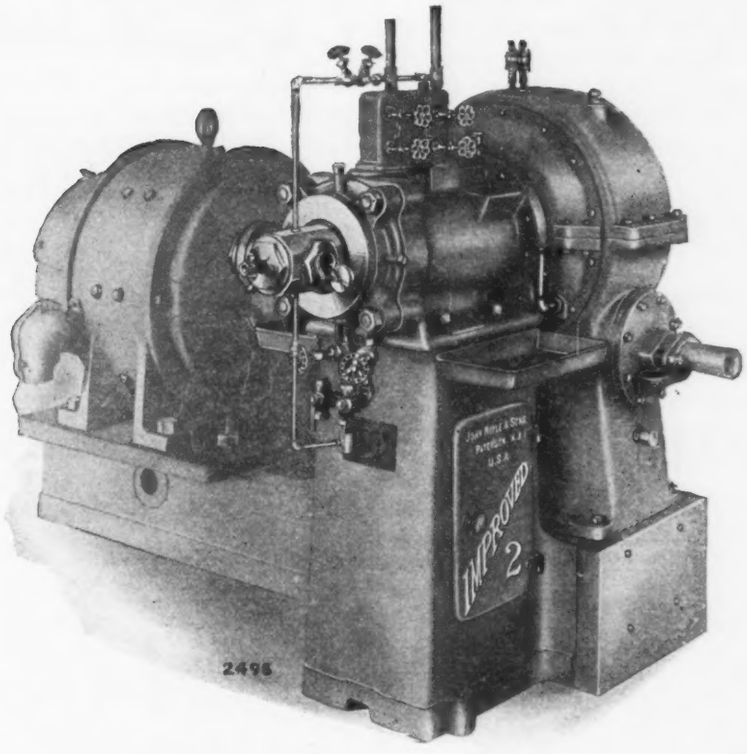
RUBBER COVERING MACHINES

for electric wire and cable



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Easy to Handle

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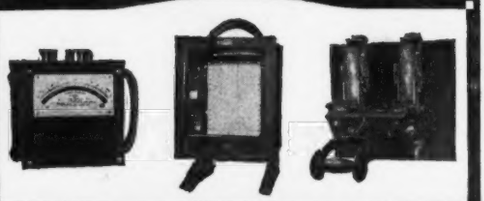

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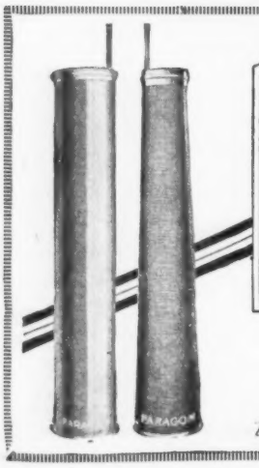

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Heavy continuous copper throughout. All joints spot welded. Insure durability, highest conductivity, lowest resistance to ground, and ample capacity. Inexpensive and easily installed with a post hole auger.

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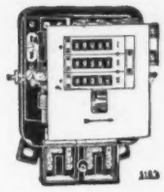
Information on 2-rate and 3-rate meters on request. (Type FBodm is the 2-rate meter.)



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TIREX cable for electric shovels, welders, dredges, conveyors, etc. gives dependable service and long life.

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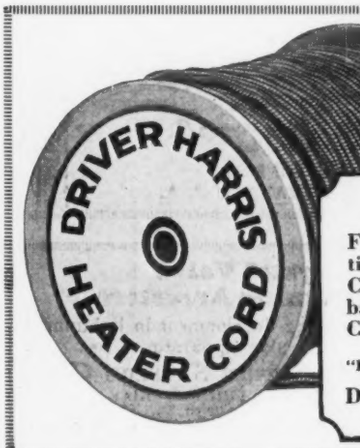

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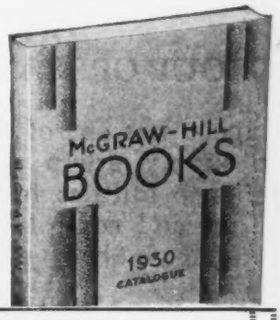

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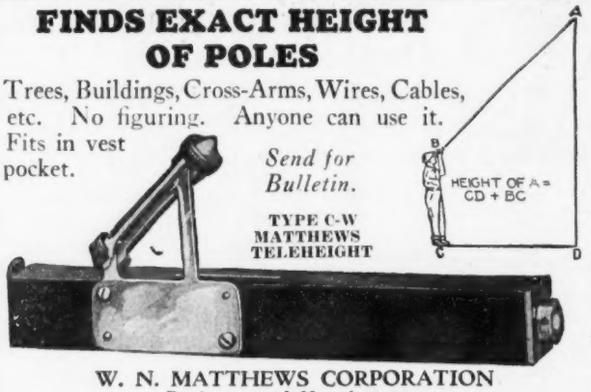

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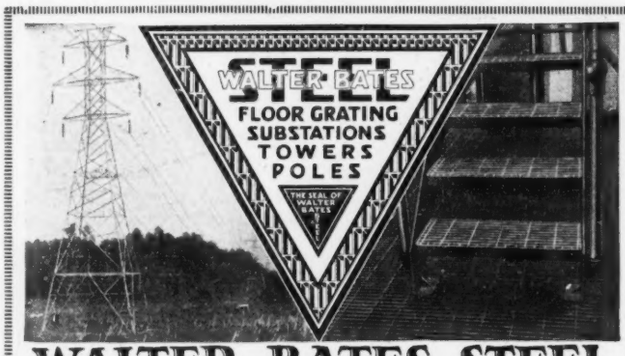

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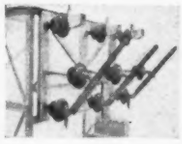

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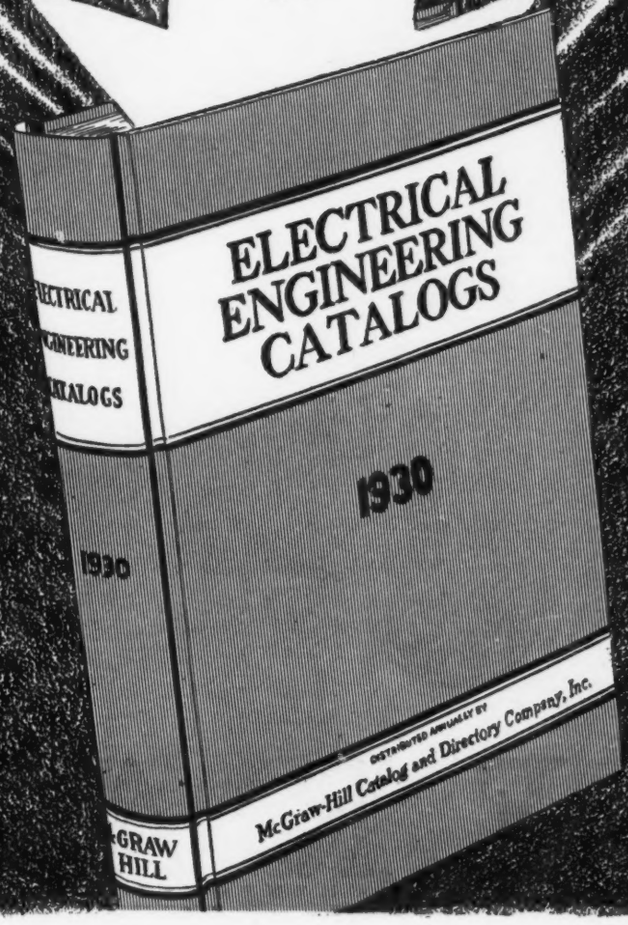

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Gray Instrument Co.
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You will find data in Electrical Engineering Catalogs on Armorclad Switchgear, Bench Type Switchboards, Distribution Panels and Cabinets, Generator Control Boards, Indoor Cubicles, Industrial Type Switchboards, Lighting Control Panels, Live-Front Vertical Type Switchboards, Metal-Clad Switchgear, Meter Control Panels and Cabinets, Meter Testing Switchboards, Motor Control Boards, Power Panels, Safety Enclosed Removable Truck Type Switchboards, Safety Enclosed Stationary Type Switchboards, Theatre Switchboards. The following manufacturers give data on many of these types of Panelboards and Switchboards in their catalogs filed in this handy catalog file:

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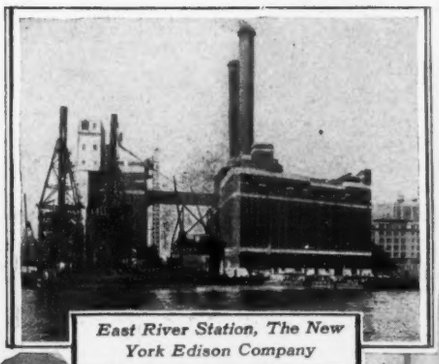
160,000 kw. from

THE newest turbine-generator in The New York Edison Company's East River Station—the most outstanding feature of the completed section—is the largest single-shaft machine in the world.

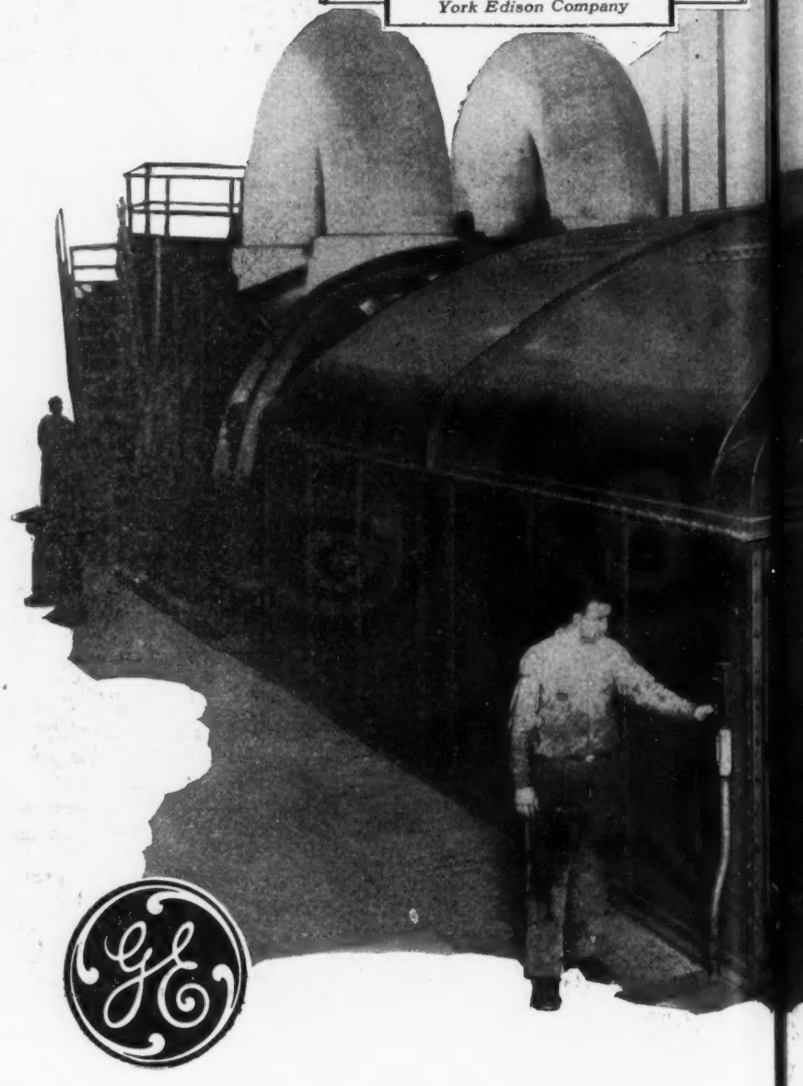
Visitors are particularly impressed with the saving of space that it has effected, especially when compared with the two other turbine-generators in this station with a total of only three-fourths as much capacity. With space at a premium in metropolitan areas, the concentration of generating capacity as achieved in the design of this 160,000-kw. G-E machine is a development of great importance.

Another notable feature is a G-E 40,000-kw. induction frequency changer. This set, and two others in Waterside station, form ties between 25-cycle and 60-cycle systems, and are the largest of this type ever built. The transformers associated with them are also the largest of their type.

The great reliance placed on General Electric design throughout this important station is indicated by the accompanying list of the more important G-E equipment installed.



East River Station, The New York Edison Company



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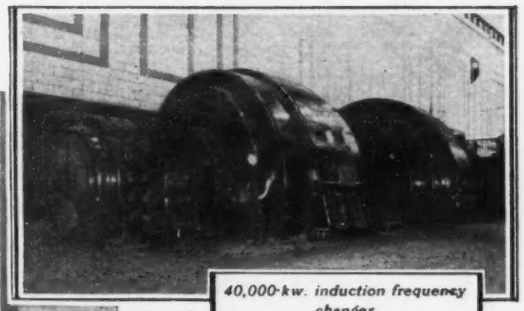
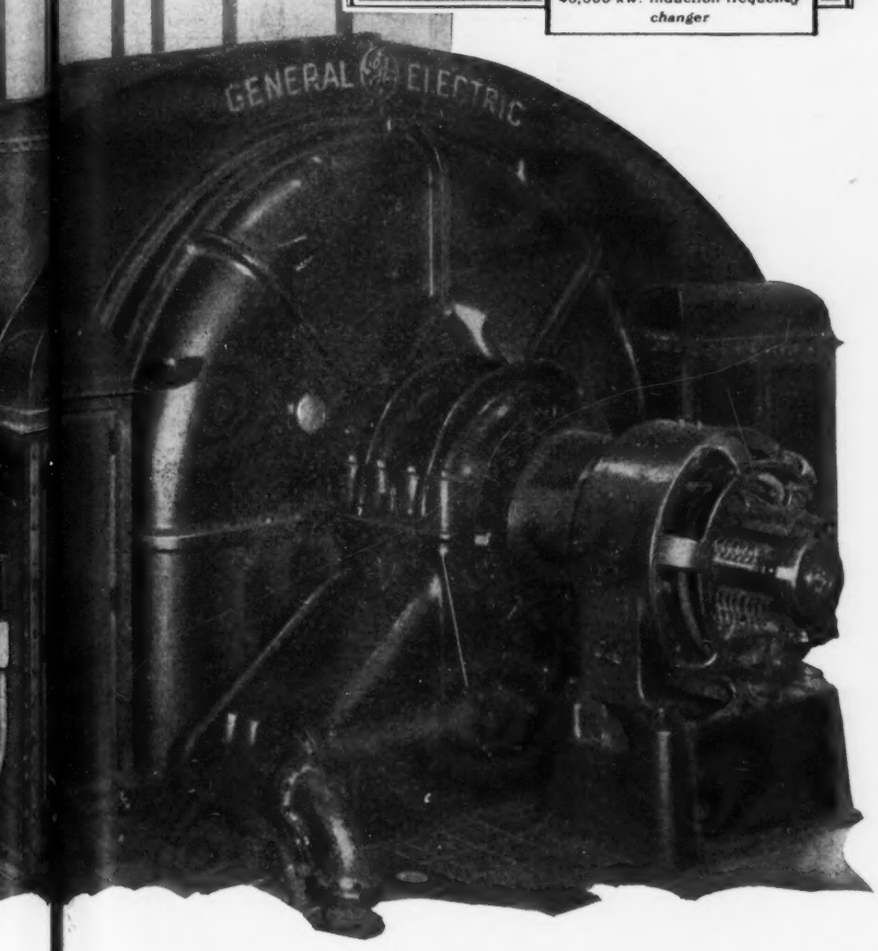
a single machine

IN EAST RIVER STATION
THE NEW YORK EDISON COMPANY



40,000-kw. induction frequency changer



G-E Equipment:—

1—160,000-kw. 25-cycle, 11,400-volt turbine-generator arranged for recirculating-air ventilation system, integral with the generator stator. This generator has the new G-E double-winding construction.

2—60,000-kw. 25-cycle, 11,400-volt turbine-generators with air coolers and fans for recirculating-air ventilation.

1—40,000-kw. induction frequency converter, also with air coolers and fans.

1—18,500-kv-a. air-blast transformer in the rotor circuit of the above converter.

119—oil circuit breakers, ranging from 600 to 5000 amp., which comprise all of the high-tension switching equipment, and are installed in the vertical isolated-phase arrangement.

120—hand-operated grounding switches for feeders.

7—control circuit breakers for frequency changer.

2—3-phase auto-transformers for grounding main and auxiliary buses.

2—18,000-kv-a. transformers for 25-cycle tie-lines

Control boards for generators, frequency changers, and all feeders; relay and totalizing switchboards; switchboards for d-c. power control, house service, and station lighting

Auxiliary steam turbines for driving the six centrifugal condenser circulating pumps and the seven boiler-feed pumps.

Dual drive, turbine and motor, for turbine-generator ventilation.

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Selsyn load-indicating devices for boiler and control rooms.

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PHOENIX, ARIZ., Luhr's Tower
PITTSBURGH, Koppers Building
PORTLAND, ORE., Failing Building
SALT LAKE CITY, Kearns Building
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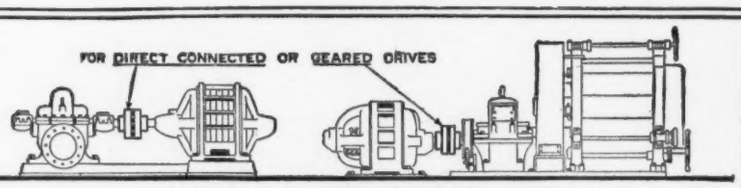
For Motors, Turbines, etc.



All Metal—Durable—Flexible in all directions—Spring cushion for load shocks and vibrations—Endwise displacement—Easy means to line up shafts—Reversible—No back lash—Noiseless—No Movement or wear on flanges—Interchangeable parts—Easily assembled—A size for any load, speed or power—Low cost and maintenance.

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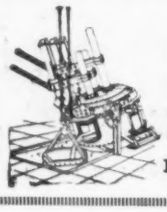

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Most Rapid and efficient for making
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The entire appliance had to be rebuilt. Domestic engineers did it so quickly and so well that the manufacturer pronounced the appliance "O. K."—but the Domestic engineers refused to stop! Perfection was almost within their grasp. "Why stop at mediocrity?" they reasoned.

Day and night they worked on, and Sundays too, until at last THEY were satisfied. As a result, the manufacturer brought to the convention a revolutionary appliance that startled the trade and resulted in a record-breaking number of orders.

WELL enough is never good enough when motors *can* be made exactly right for the purpose they are to serve. Nothing short of Domestic's best will ever do.

Perhaps that explains, in part, why so many of the nation's leading builders of electric-powered appliances, in commercial, household and industrial fields have such implicit faith in Domestic's ability and in the quality of its work . . . why many of them come to Domestic engineers not only with their problems of motor application, but with problems of appliance design, manufacture and marketing as well . . . why Domestic has grown to be the world's largest manufacturer of individually designed and built fractional horsepower motors.

Domestic's experience over a period of more than 16 years embraces an almost unbelievable variety of individual motor application problems. It is an experience that explains how it is possible for Domestic to master so quickly, thoroughly and economically the many problems of its customers.

THE DOMESTIC ELECTRIC COMPANY
KENT, OHIO (174)

Courtesy Office—967 Union Trust Bldg., Cleveland, Ohio

Domestic
FRACTIONAL HORSEPOWER
Electric Motors

SMALL MOTOR MANUFACTURE • • APPLIANCE ADVISORY ENGINEERING

TRADITION

"Linc-Weld" Superiority is due to:
1. Larger Shafts
2. Larger Bearings
3. Better Insulation
4. Stronger Frame (Steel)
5. Greater Overload Capacity

"Here, Lad—

It beats all how welded steel design is getting into all sorts of machinery.

Every piece of equipment we've bought this year has been steel construction—and proved good.

Why not make it a cast iron rule to buy only welded steel equipment?"

"Fine, Pop—

but make it a STEEL rule.

It's less easily broken.

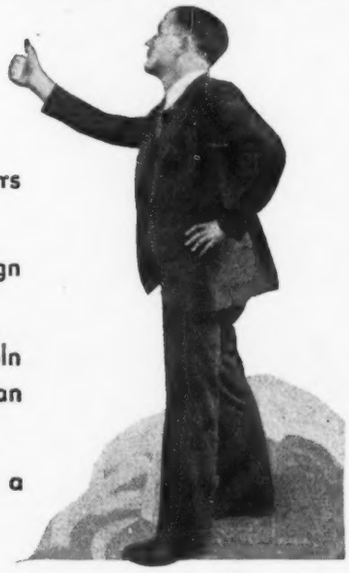
And what is most important, let's put the motors we buy in that class.

The Lincoln 'Linc-Weld' motor is all steel design—modern—better.

This steel construction has given the Lincoln people a chance to give us more in a motor than is possible with cast construction.

The improvements are plentiful as pins in a new shirt."

PROGRESS



THE LINCOLN ELECTRIC COMPANY
Department No. 1-6 CLEVELAND, OHIO

M-59

LINCOLN
"LINC-WELD" MOTORS

Limit Switches which co-operate with Motor Control

THE dependable operation of Motor Control in many cases depends upon the control-accessories. So does production. With the failure of *one* limit switch, your processes can be snarled up . . . halted . . . the value of an investment of thousands of dollars impaired. Therefore, when you select limit switches make your choice with the utmost care . . . make sure that these accessories actually help your control perform its duty.

The Cutler-Hammer Line of Limit Switches has been designed and built with full realization of the responsibilities placed upon this equipment. They are the fruits of 30 years' intimate contact with the needs of American Industry . . . the fruits of 30 years' experience in the electrical control field. They are built to the highest standards of ruggedness, durability and performance. You are invited to investigate this line carefully . . . and to see how you and your production can depend on it . . . for all time. A letter will bring you further information.

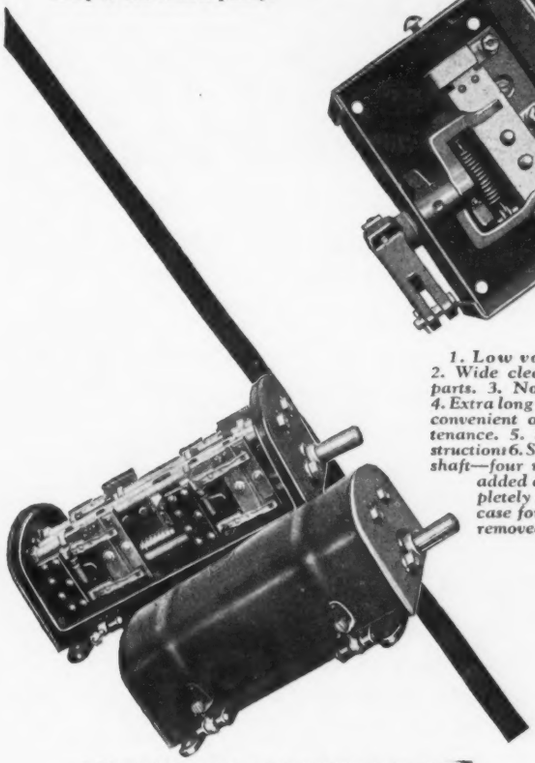
CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1329 St. Paul Avenue
MILWAUKEE, WISCONSIN

C-H LIMIT SWITCHES BULLETIN 1271

1. Can be used on doors, machines, conveyors, etc. 2. Push-button, roller-lever or gravity operation. 3. Right or left-hand mounting; normally open or normally closed contacts, for wide variety of uses. 4. Rugged construction for long service. 5. Easily renewable contacts. 6. Dust-proof case. 7. Double-break protection against shorts, etc. 8. Up to 600 volts capacity.

C-H LEVER-OPERATED MASTER SWITCH BULLETIN 10252

1. Low voltage protection. 2. Wide clearance between live parts. 3. Non-stubbing contacts. 4. Extra long bronze bearings with convenient oil holes—low maintenance. 5. Simple, rugged construction 6. Square operating lever shaft—four mounting positions—added adaptability. 7. Completely enclosed extra heavy case for safety. Cover easily removed.



C-H TRAVELING CAM LIMIT SWITCH BULLETIN 10312

1. Wide range of adjustment, extreme accuracy in stopping. 2. Double-pole contacts prevent accidental grounds or shorts. 3. Contacts, quick break type; when adjusted to the tripping point can be positively locked to that position. 4. Rugged construction throughout. Bearings bronze-bushed. Dust-proof cover. 5. Contacts and fingers are standard C-H construction.

C-H CRANE SAFETY LIMIT SWITCH BULLETIN 10111

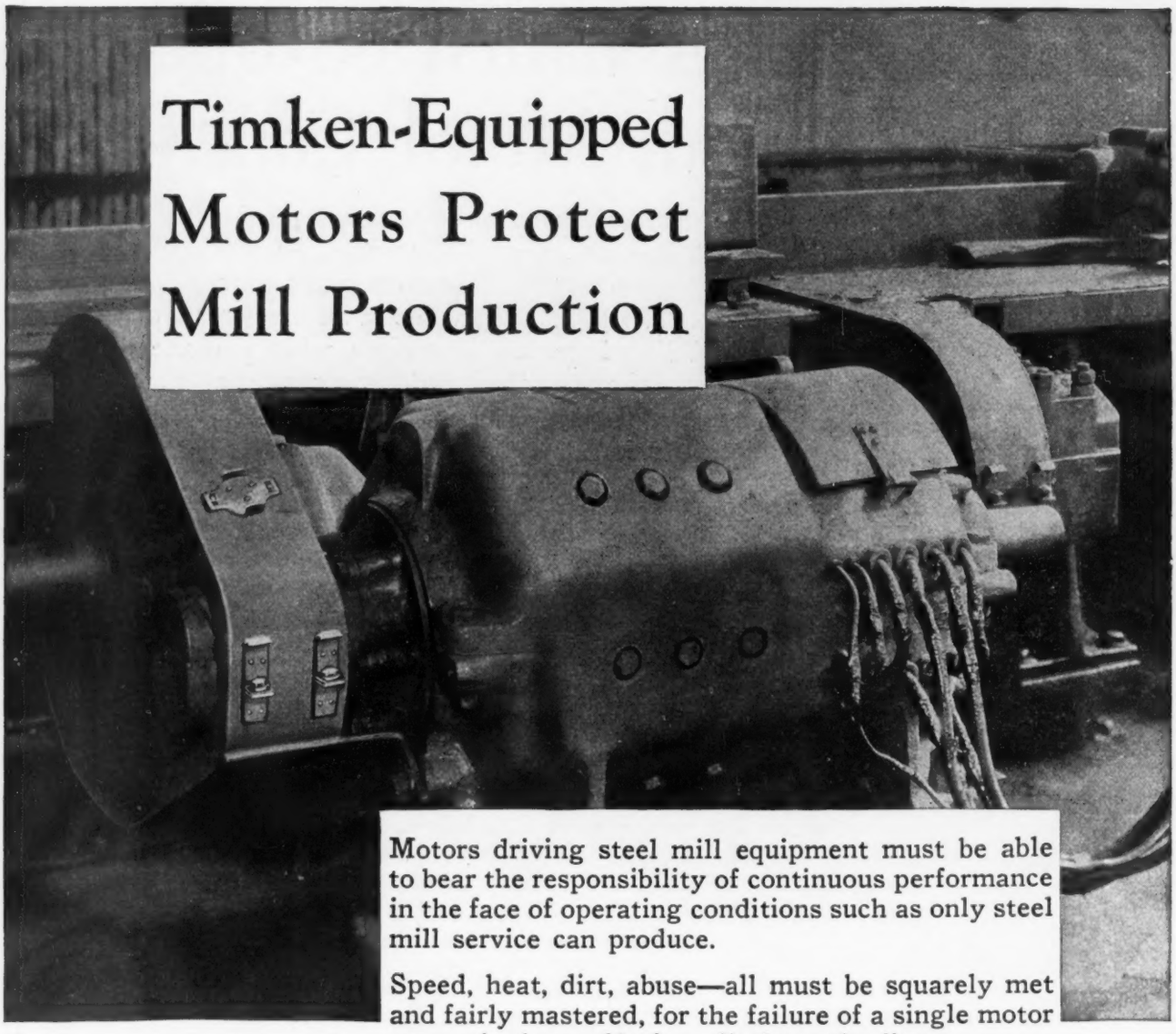
1. Compact size—mounting in 4 positions. Easily wired. 2. No pilot circuit required. 3. Dynamic braking, quick positive stopping. 4. Quick acting contacts—automatic reset. Contacts and shields easily renewable—interchangeable with standard mill type contactor parts. 5. Rugged construction throughout. 6. Tripping weight an integral part of switch. 7. Built in two sizes.

CUTLER HAMMER

C-H

The Control Equipment Good Electric Motors Deserve

(A-284)



Timken-Equipped Motors Protect Mill Production

Motors driving steel mill equipment must be able to bear the responsibility of continuous performance in the face of operating conditions such as only steel mill service can produce.

Speed, heat, dirt, abuse—all must be squarely met and fairly mastered, for the failure of a single motor may cripple production all along the line.

In one large steel plant 193 of these motors are in constant operation day and night.

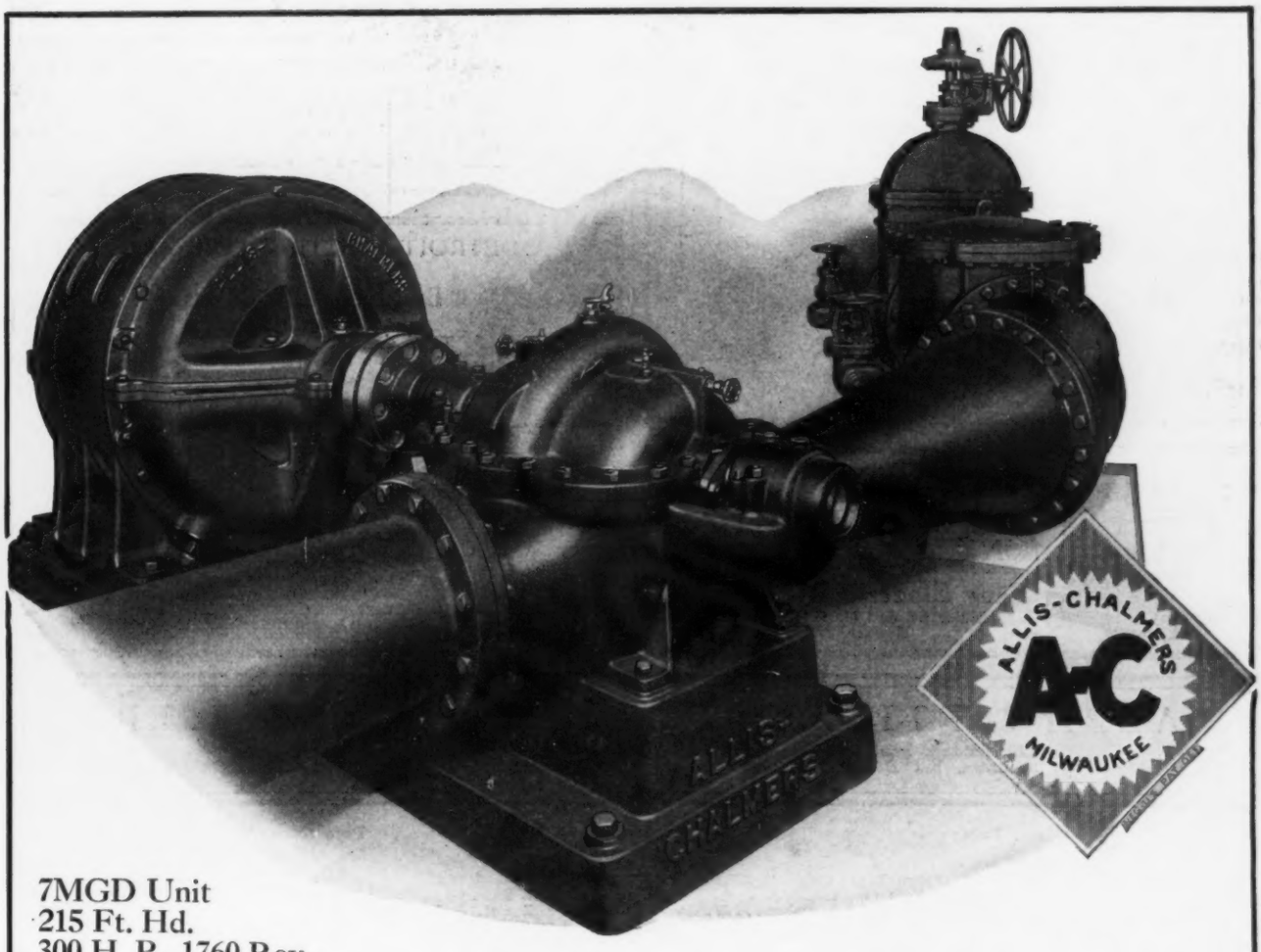
TIMKEN BEARING EQUIPPED

The mill motor problem is mostly a bearing problem . . . it has been solved by "Timken Bearing Equipped."

With motors protected by the exclusive combination of Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made steel, friction becomes a dead issue; lubrication loses its significance; the heaviest radial, thrust and resultant loads are surely and safely carried; and maintenance costs drift steadily downwards.

THE TIMKEN ROLLER BEARING COMPANY
C A N T O N , O H I O

TIMKEN *Tapered Roller* **BEARINGS**



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215 Ft. Hd.
300 H. P., 1760 Rev.
Motor 78%
Combined Efficiency

MORE EFFICIENT PUMPING

Allis-Chalmers improved Centrifugal Pumps and Motors are steadily decreasing pumping costs. Over 73 per cent combined efficiency from a two million gallon unit to over 84 per cent from a twenty million gallon unit shows what is possible under suitable conditions. This means a widening of the field of application for the simple, inexpensive motor-driven pump. Our engineers will assist you in the proper application of Allis-Chalmers efficient pumps to your needs.

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MILWAUKEE, WIS. U. S. A.

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1 OF 21

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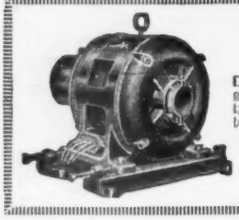

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ALPHABETICAL INDEX TO ADVERTISERS

This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Electrical World* assumes no responsibility for errors or omissions.

Page

A

Acme Wire Co. 32
Allied Engineers, Inc. 26
Allis-Chalmers Mfg. Co. 10, 45
Aluminum Co. of America. 15
Ambursen Constr. Co. 26
American Insulating Mchy. Co. . 32
American Pipe Bend. Mach. Co., Inc. 46
American Steel & Wire Co. . . . B.C.

B

Babcock & Wilcox Co. 40
Baehr, William A. 26
Bakelite Corp. 31
Baldor Electric Co. 40
Barker & Wheeler 26
Barrows, H. K. 26
Bates Expanded Steel Truss Co. 36
Bates Steel Corp., Walter. 36
Battey & Kipp 26
Biddle, Jas. G. 20
Black & Veatch 26
Blake Signal & Mfg. Co. 31
Brewer-Titchener Corp. 7
Byllesby 26

C

Canadian Porcelain Co., Ltd. . . . 32
Carolina Wood Preserving Co. . 8
Chance Company 36
Cheney, Edward J. 26
Colt's Patent Fire Arms Mfg. Co. 18
Cooper, Hugh L. 26
Copperweld Steel Co. 36
Coppus Eng. Corp. 35
Cutler-Hammer, Inc. 43

D

Daley & Co., Inc., M. J. 26
Detroit Electric Furnace Co. . . . 46
Directory of Engineers. 26, 27
Domestic Electric Co. 41
Dorsey & Co., Victor A. 26
Driver-Harris Co. 35

E

Electric Bond & Share Co. . . . 40
Electric Power Equip. Corp. . . . 36
Electric Service Supplies Co. . . . 36
Electric Storage Battery Co. . . . 24
Electrical Engrs. Equip. Co. . . . 11
Electrical Testing Laboratories. . 22
Electrical World 3
Empire Steel Corp. 31
Engineers, Directory of. 26, 27

Page

F

Fargo Engr. Co. 26
Felters Co., Inc. 31
Fibre Conduit Co. 34
Ford Bacon & Davis, Inc. 26
Fowle, Frank F. 26

G

G. & W. Elec. Spec. Co. 5
General Cable Corp. 12
General Electric Co. 38, 39
General Elec. Vapor Lamp Co. . 36
Graybar Elec. Co. 34

H

Hall Elec. Heating Co., Inc. . . . 26
Harza, L. F. 26
Hi-Voltage Equip. Co. 36
Hoosier Engr. Co. 26
Hoxie, Geo. L. 26
Hubbard & Co. 14

I

Imperial Porcelain Works. 31
Indiana Steel & Wire Co. 32
Irvington Varnish & Ins. Co. . . . 32
I-T-E Circuit Breaker Co., Third Cover
Ives & Davidson 26

J

Jeffery-Dewitt Ins. Co. 35
Johns-Manville Corp. 34

K

Kearney Corp., Jas. R. 13
Kelso-Wagner Co. 23
Kidde & Co., Inc., Walter. . . . . B.C.
Kuntson, Geo. H. 26

L

Lacomb, Chas. F. 26
Landis & Gyr, Inc. 35
Lapp Insulator Co., Inc. 36
Lee, Wm. S. 26
Leffler, Wm. S. 26
Lincoln Electric Co. 42
Lucas & Luick. 26

Page

M

McClintic-Marshall Co. 34
McGraw-Hill Book Co. 31, 35
McGraw-Hill Cat. & Dir. Co. . . 37
Main Inc., Chas. T. 26
Marble-Card Electric Co. 46
Matthews Corp., W. N. 36
Mead, Daniel W. 27
Meter Devices Co. 19
Mullegren, Arthur L. 27

N

Newport Rolling Mill Co. 32

O

Ohio Brass Co. 9
Okonite-Callender Cable Co., Inc. 4
Okonite Co., Inc. 4
Ophuls & Hill, Inc. 37
Oliver Iron & Steel Co. 35
Osgood, Farley 27

P

Pacific Elec. Mfg. Corp. . . . . F.C.
Paragon Electric Co. 34
Pittsburgh Elec. Furnace Corp. . 40
Porcelain Inc., Corp. 34
Portland-Monson Slate Co. 32

R

Railway & Ind. Engr. Co. 6
Reed, W. Edgar. 27
Rockbestos Prod. Corp. 21
Roebling's Sons Co., John A. . . 34
Roller-Smith Co. 34
Royle & Sons, John. 33

S

Sanderson & Porter. 27
Sangamo Electric Co. 25
Sargent & Lundy. 27
Schiedenhelm, F. W. 27
Scofield Engineering Co. 27
Searchlight Section 28, 30
Simplex Jack Co. 34
Simplex Wire & Cable Co. 35
Smith & Serrell 40

Page

Squire, W. J. 27
Star Elec. Motor Co. 46
Steward Mfg. Co., D. M. 31

T

Tanner Eng. Co. 46
Timken Roller Bear. Co. 44
Tomasuri, Masa 27

V

Viking Tool & Machine Co. 32

W

Walter Bates Steel Corp. 36
Westinghouse Elec. & Mfg. Co., 16, 17
Weston Elec'l Instr. Corp., Second Cover
Wheeler Mfg. Co., C. H. 40
White Eng. Corp., J. G. 27
Woodward Governor Co. 40
Wray & Co. J. G. 27

For PRODUCTS INDEX of Electrical and Allied Products see "ELECTRICAL ENGINEERING CATALOGS"

write to Reader Service Department of ELECTRICAL WORLD for "where-to-buy" data on any products in which you may be interested.

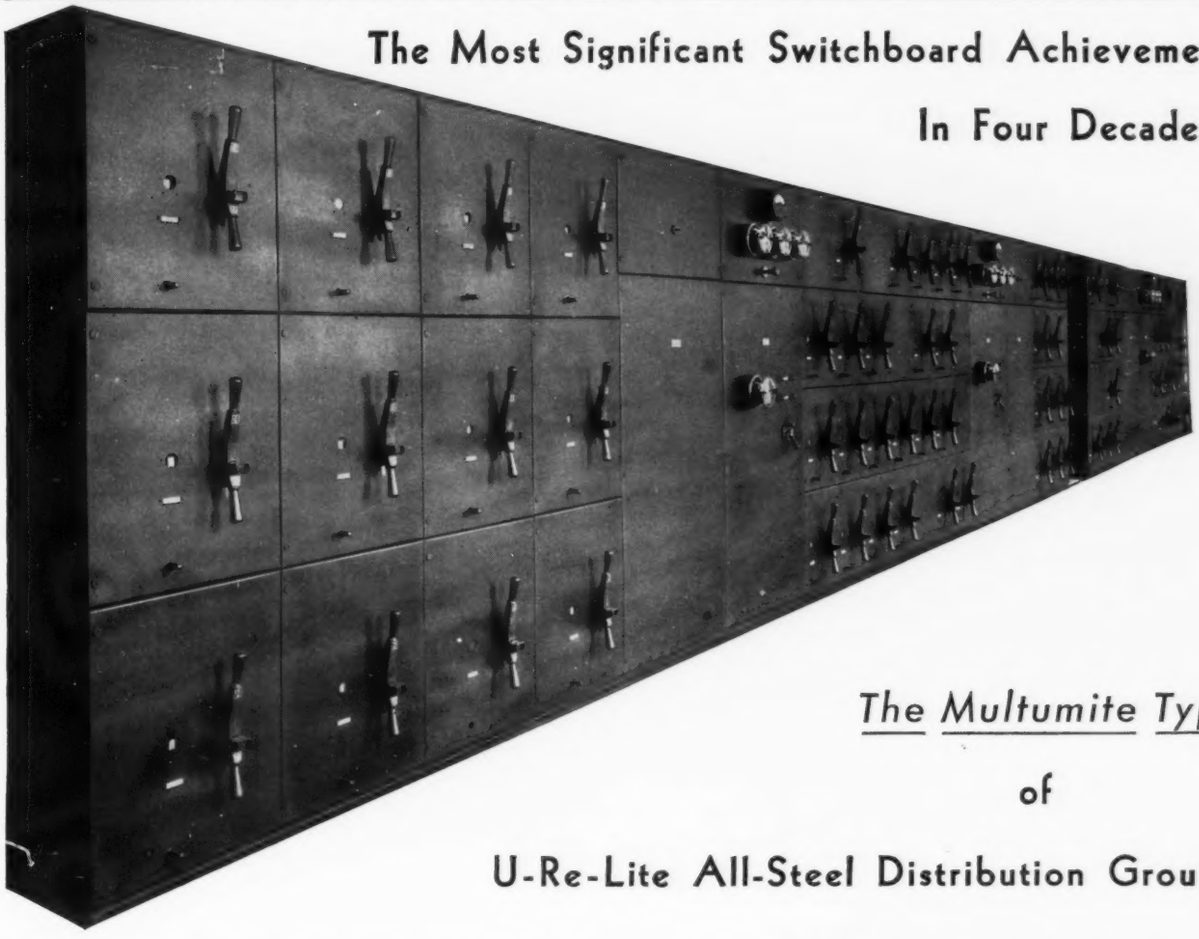
SEARCHLIGHT SECTION

Classified Advertising

Classification Page

BUSINESS OPPORTUNITIES . . 28
EDUCATIONAL COURSES . . . 28
BOOKS 28
POSITIONS VACANT 28
POSITIONS WANTED 28
REPRESENTATIVES AVAILABLE 28
WANTED TO PURCHASE . . . 28
USED and SURPLUS EQUIPMENT 28-30
Archer & Baldwin, Inc. 28
Belyea Co., Inc. 30
Central Illinois Public Service Co. 29
Dayton Machinery & Supply Co. 29
Delta Equip. Co. 30
Electric Service Co., Inc., The. 29
Fuerst-Friedman Co. 28
Hall & Co., Inc., Stephen 30
Hemphill & Co., J. L. 29
Land, L. J. 30
Randle Mchy. Co. 30
Rockford Power Mchy. Co. . . . 28
Sachsenmaier Co., George 30
Scheinert, R. 30
Stewart & Co., Paul 30
Stirewalt, N. C. 29
ELEC. WORLD ENGINEERING SERVICE DIRECTORY . . . 26-27

The Most Significant Switchboard Achievement In Four Decades!



The Multumite Type of U-Re-Lite All-Steel Distribution Groups

Forty years ago, open switchboards consisted of switches, circuit breakers and meters, mounted on marble. Open switchboards today are practically the same, using slate instead of marble and with refinements in switches, circuit breakers and meters.

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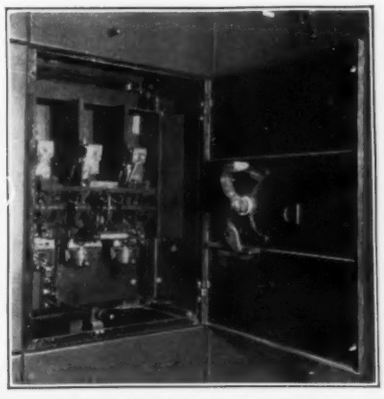
The Multumite group combines these significant advantages:—

1. *Utmost Safety to Operators*—every live part, including buses, enclosed in steel—circuit breakers operated by insulated external U-Re-Lite handles and non-closable against overload or short circuit.

2. *Protection and Control*—positive overload and short circuit protection and time delay for lighting circuits—across-the-line starting of motors, combined with overload and short circuit protection.

3 *Rupturing Capacity*—U-Re-Lites with the new Min-Arc-Ite (minimum arc) barriers have higher rupturing capacities at 550 volts A.C. and under than any protective equipment of a like nature.

4. *Space Saving*—in less than one-third the length of an open switchboard, this group protects three 2500 ampere main circuits, with automatic transfer from normal to emergency source; 66 feeder circuits ranging from 200 amperes to 1250 amperes each; and provides for 14 future feeders.



5. *Easy Accessibility*—to inspect the circuit breakers it is only necessary to open the hinged doors.

6. *Double Disconnects*—any feeder circuit breaker can be disconnected from the line and the load, easily and safely by means of disconnecting contacts on the rear of the circuit breaker panels (Hingite construction).

7. *Minimum Field Work*—these groups are shipped complete, can be inspected before shipment and the only field work required is bolting to floor channels, making main bus connections and running in feeder cables.

8. *Flexibility*—provision for future feeders can be made in present groups, or future groups can be added any time.

9. *Appearance*—the black Duco finish, the flush fronts and backs, and the uniform height of these groups add to the workmanlike appearance of any modern power plant.

It will pay you to study the application of a Multumite group to your switchboard requirements—get in touch with the nearest I-T-E representative.

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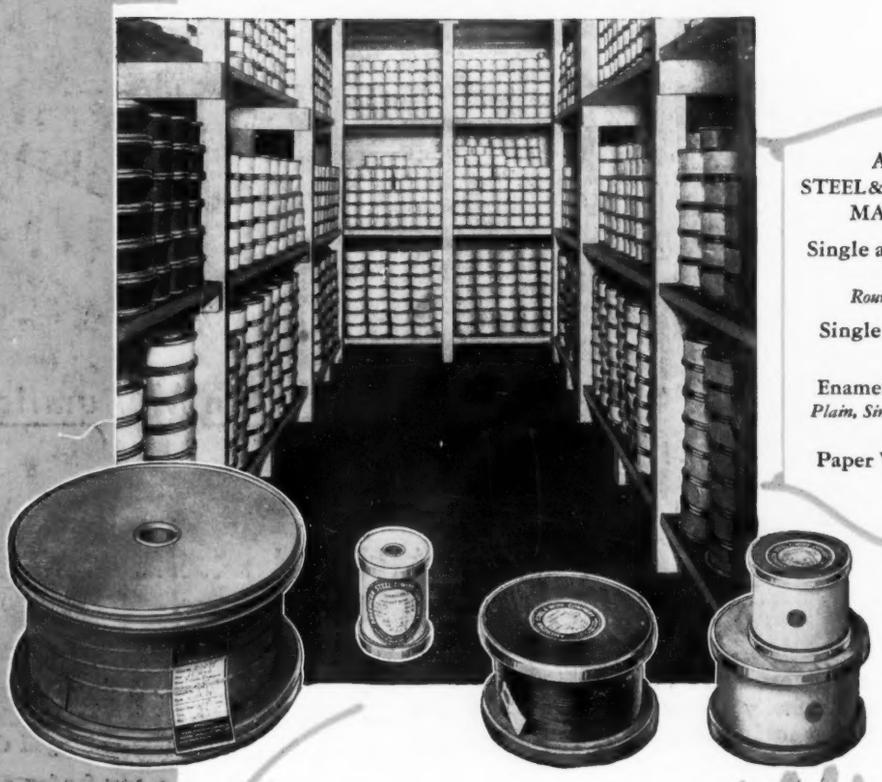

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